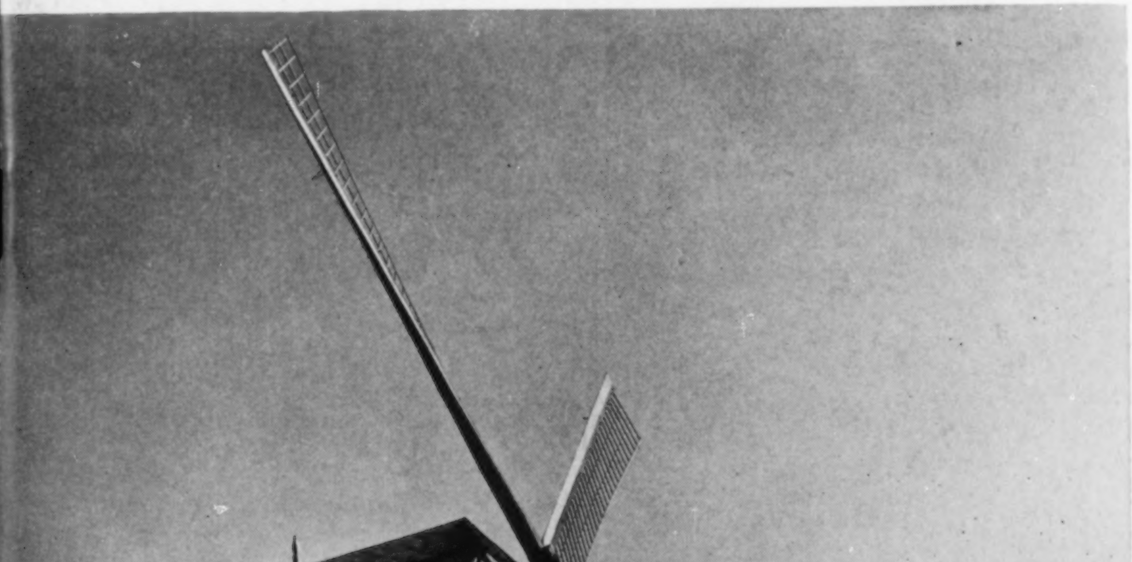
Compressed Air Magazine

NOVEMBER 1944

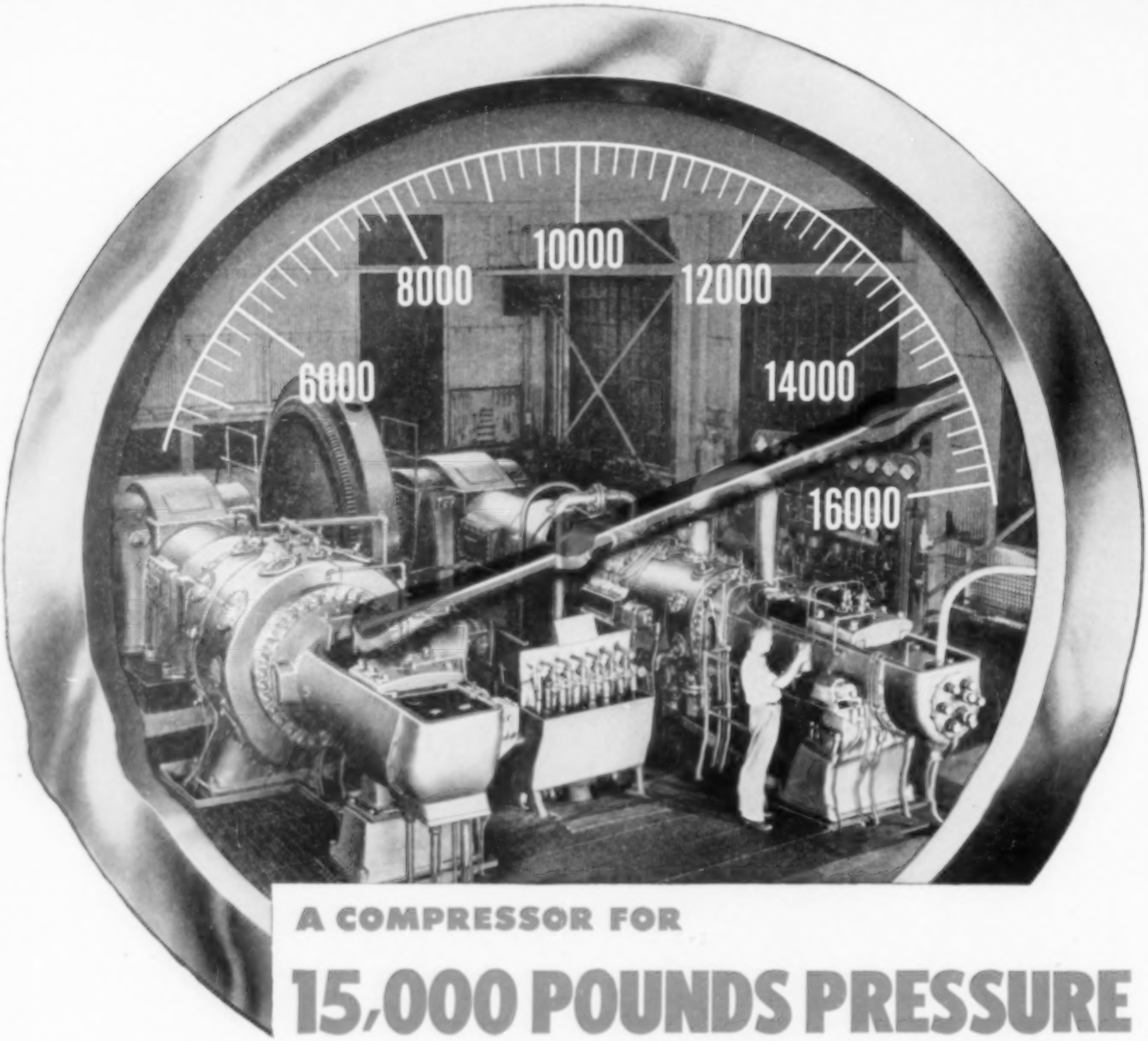


A WINDMILL OF THE OLD WORLD

A means of harnessing air power that man has used for 800 years.

VOLUME 49 • NUMBER 11

NEW YORK • LONDON



A COMPRESSOR FOR

15,000 POUNDS PRESSURE

The compressor pictured above operates at a pressure greater than the water pressure at the bottom of the deepest ocean—6½ miles down. It has the power of a big locomotive. Its 4-foot diameter cylinder inhales about a box-car full of gas every minute through a 20-inch intake pipe. After being compressed to the tremendous pressure of 15,000 lb per sq inch, the gas leaves the machine through a pipe of less than 1-inch inside diameter.

This 2500-horsepower machine is one of six Ingersoll-Rand 7-stage units built for Hercules Powder Company to compress a mixture of nitrogen and hydrogen for the manufacture of ammonia—a vital synthetic used to make explosives and fertilizers.

Synthesizing ammonia is only one of many high-pressure processes that use I-R compressors in the petroleum, chemical, food, and process industries. Developing and building compressors for such applications is another phase of Ingersoll-Rand engineering.

If you have a problem involving the compression of air or gas...no matter how high the pressure...Ingersoll-Rand experience can help you.

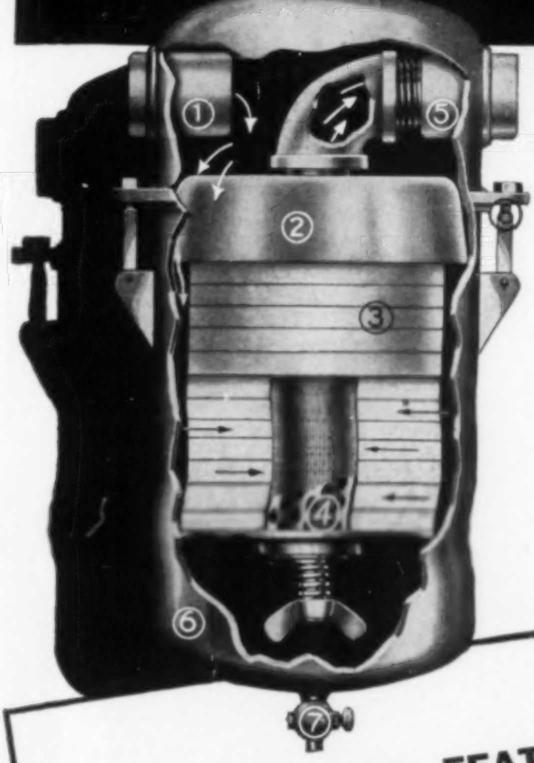
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

1-470

COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

HAZARD of Oil and Moisture in Automatic Controls NOW ELIMINATED



New Filter Delivers Dry Air Only

Amazing results are being reported by users of the Model AAPHS Pipe Line Filter as a final stage in the protection of delicate pneumatic control instruments.

Typical comment is that of a large producer of electric and steam power who says, "We tried several well-known methods of moisture and oil elimination without satisfactory results. Your Model AAPHS was finally installed in the air line *and since then we have had no trouble whatever with oil or moisture in our automatic controls."*

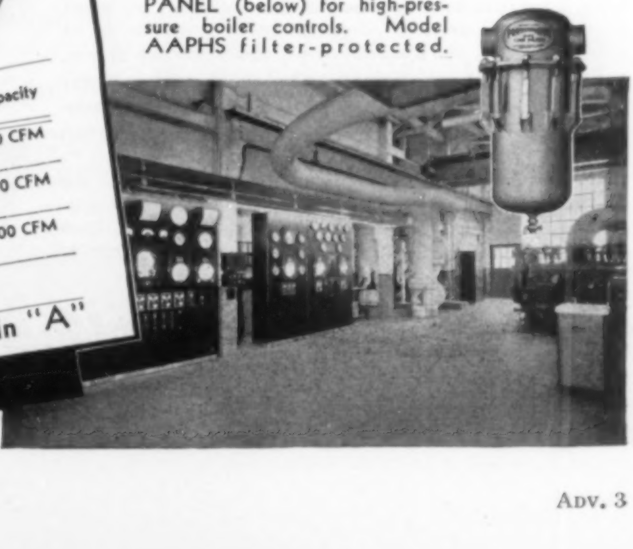
NEW 44-PAGE CATALOG: Describes *entire line, including filters for building ventilation, pipe lines, engine, and compressor intakes. Your copy is ready.*

DOLLINGER CORPORATION
(Formerly Staynew Filter Corp.)
7 CENTRE PARK, ROCHESTER 4, N. Y.

"Air Filter Headquarters"

STAYNEW
PROTECTOMOTOR
FILTERS

PANEL (below) for high-pressure boiler controls. Model AAPHS filter-protected.



CONSTRUCTION FEATURES

(1) inlet, (2) baffle that distributes vapor-laden air to sides of container (6), (3) felt rings, (4) perforated liner, (5) outlet, (7) drain cock, (8) swing bolts for easy inspection (optional).

THICK FELT RINGS that remove every trace of oil or moisture.

SPECIFICATIONS

Model	Standard Pipe Size	Capacity	Model	Standard Pipe Size	Capacity
AAPH-02 AAPHS-02	¼"	5 CFM	AAPH-2 AAPHS-2	1"	30 CFM
AAPH-01 AAPHS-01	¼"	7 CFM	AAPH-4 AAPHS-4	1½"	50 CFM
AAPH-0 AAPHS-0	½"	10 CFM	AAPH-5 AAPHS-5	2"	100 CFM
AAPH-1 AAPHS-1	¾"	20 CFM			

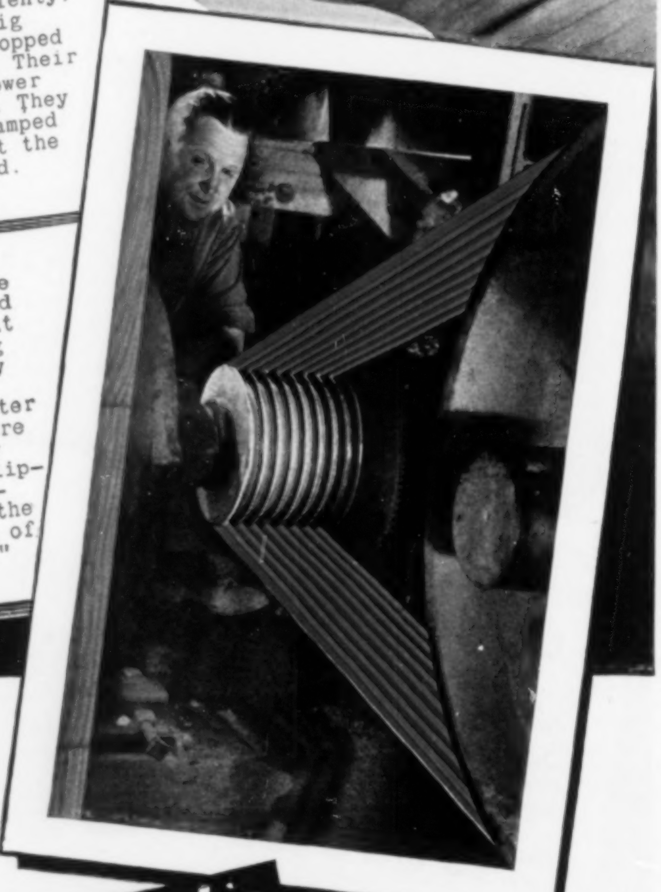
Letter S in code numbers indicates swing-bolt type which facilitates inspection.

Write for Bulletin "A"

DAYTON V-BELT DISTRIBUTORS HELP SOLVE UNIQUE DRIVE PROBLEMS

TROUBLE! A war-busy Washed Sand & Gravel Company ran into trouble aplenty. They worked into coarser deposits. Big boulders clogged the buckets, and stopped the 9" x 36" jaw crusher repeatedly. Their belts were slipping. More driving power and a scalping screen were required. They were skeptical because they were cramped for room underneath the machine. But the Dayton V-Belt Distributor was called.

LICKED! As a result, the company switched to Dayton V-Flat Drives, running 8 belts off a 10.6" V-Groove pulley on a 50 H.P. Motor, over to one of the 36" Fly wheels. (55 inches center to center.) And then they ran 3 more Dayton V-Belts up to a flat pulley operating a new scalping screen. Slippage stopped. Shut-downs were eliminated. Trouble was licked. And the boss claims "A better appreciation of Dayton V-Belts than I had before."



Your Dayton V-Belt Distributor is Glad to Help You Lick Drive Troubles

Whenever you have *any* power transmission problem . . . of conversion, or of redesign, or a check-up of trouble or loss of efficiency from your present drives, call in the Dayton V-Belt Distributor. He will engineer and help you install the quick, dependable, smooth-running, full-positive-power-transmission of Dayton V-to-V or Dayton V-Flat Drives.

Remember, the name Dayton Rubber stands for Technical Excellence in Synthetic Rubber development. And your Dayton V-Belt Distributor is there to bring you every benefit of Dayton's 38 years of successful assistance to Industry.

CALL YOUR DAYTON V-BELT DISTRIBUTOR OR WRITE DIRECT

THE DAYTON RUBBER MFG. CO., DAYTON 1, OHIO
The World's Largest Manufacturer of V-Belts
Export Division: DAYTON RUBBER EXPORT CORPORATION
38 Pearl St., New York, N.Y., U.S.A. *Cable Address:* WIDBLOCO

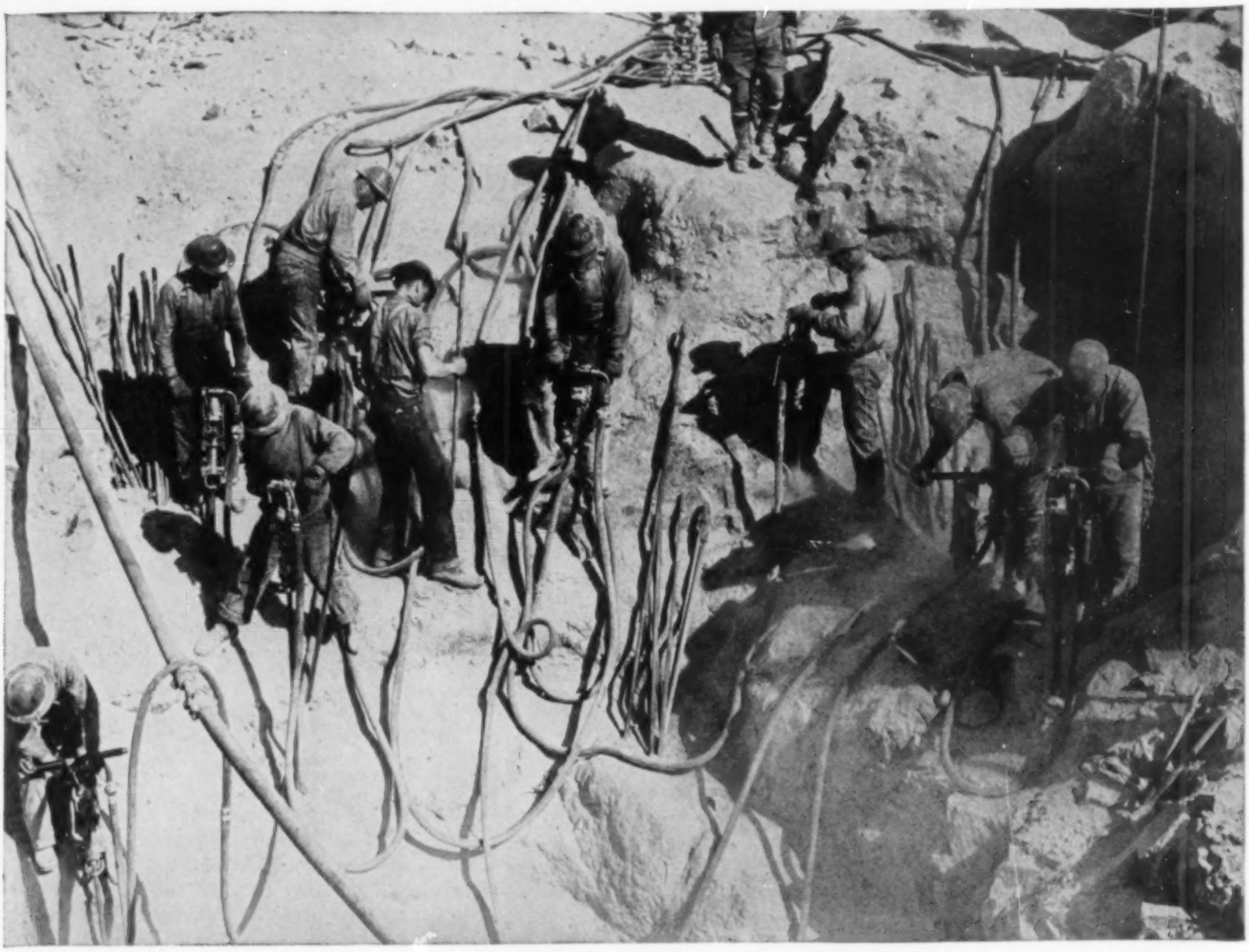
MAINTAIN VICTORY SPEEDS—CONSERVE YOUR TIRES

V-Belts by

Dayton Rubber

REG. TRADE MARK THE DAYTON RUBBER MFG. CO.

The Mark of Technical Excellence in Synthetic Rubber



Air Support for Ground Operations

To supply the continuous "air support" necessary to maintain the pace of "ground operations" involving the use of rock drills and other pneumatic tools, air compressors must operate at top efficiency.

Because of the importance of *effective* lubrication in securing efficient performance, experienced operators lubricate their compressors with *Texaco.*

Texaco Alcaid, Algol or *Ursa Oils* assure wide-opening, tight-closing valves, free piston rings, open ports, clear lines, continuous air supply. They also assure maximum service life between overhauls, fewer repairs and replacements. Their use in air compressors is nationwide.

Texaco lubricants have proved so effective in service they are definitely preferred in many fields, a few of which are listed at the right.

Texaco Lubrication Engineering Service is available to you through more than 2300 Texaco distributing points in the 48 States.

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THEY PREFER TEXACO

★ *More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.*

★ *More revenue airline miles in the U. S. are flown with Texaco than with any other brand.*

★ *More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.*

★ *More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.*

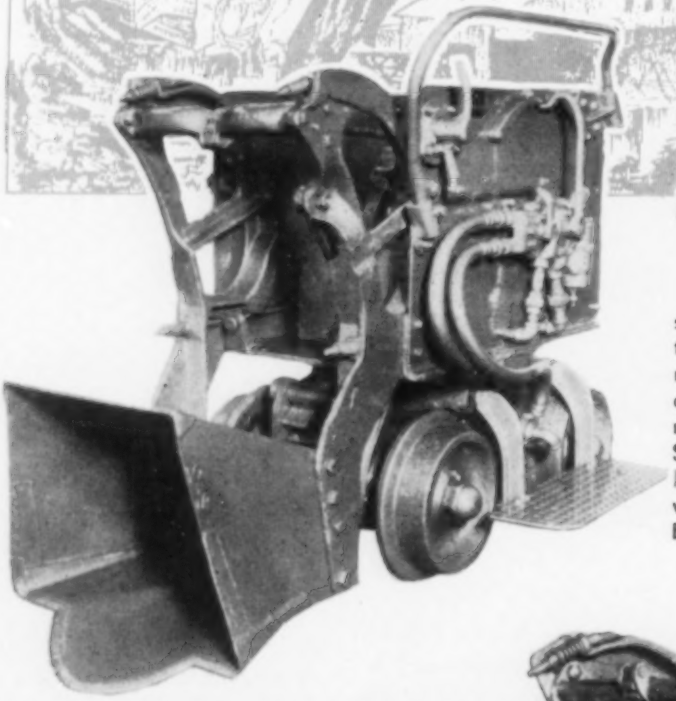
★ *More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.*

TEXACO
REG. T.M.

TEXACO Lubricants

FOR ALL AIR COMPRESSORS AND TOOLS

TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT — CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

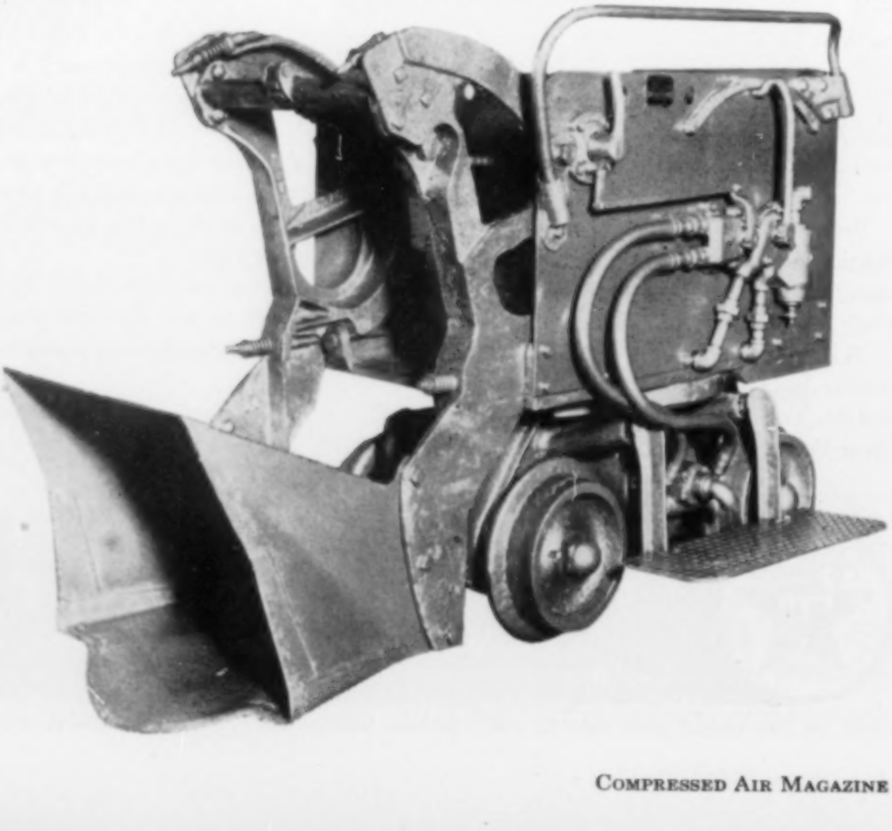


RockerShovel

for the Post-War

After the Victory parades, after the tumult and the shouting, the world will look to peace and reconstruction. Exhausted natural resources will have to be replaced; cities and towns rebuilt, the work of men and machines will be needed to restore the things ravaged by war. Eimco offers its Parade of Rocker Shovels as a contribution to that purpose. Mechanical loading of materials on the surface and underground will speed the return to normal and for every job an Eimco RockerShovel is available.

Eimco RockerShovels by the thousand have worked



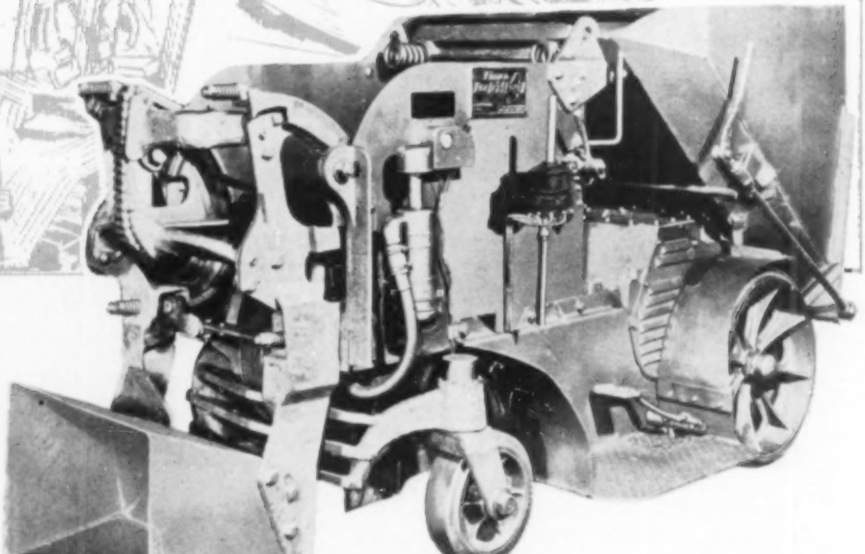
MODEL 12B

Equipped with heavy duty five-cylinder pneumatic motors; capacity 1 to 2 tons per minute, weight 4200 pounds, track gauges 15" to 36".

MODEL 21

Powered by heavy duty electric or 5 cylinder air motors, capacity 2 to 3 tons per minute, weight 7200 pounds, track gauges 18" to 48".

A 77



Parade

World

night and day in all parts of the world to bring Victory through production and in the post-war period RockerShovels will continue to operate at maximum capacity with low cost maintenance. Eimco service engineers will again give to users the full benefit of their world-wide experience. Eimco's designing engineers will add new features and improvements to retain for Eimco its leadership in mechanical loading.

TRANSPORT MODEL

For stockpiling, loading into hoppers, for unloading boxcars, ships, batch mixing plants, or other loading jobs requiring a trackless operation.

MODEL 40

Equipped with a ½ cubic yard bucket, powered by air or electric motors, capacity 3 to 5 tons per minute, weight 14,000 lbs. Track gauges 30" to Standard railroad gauge.

EIMCO

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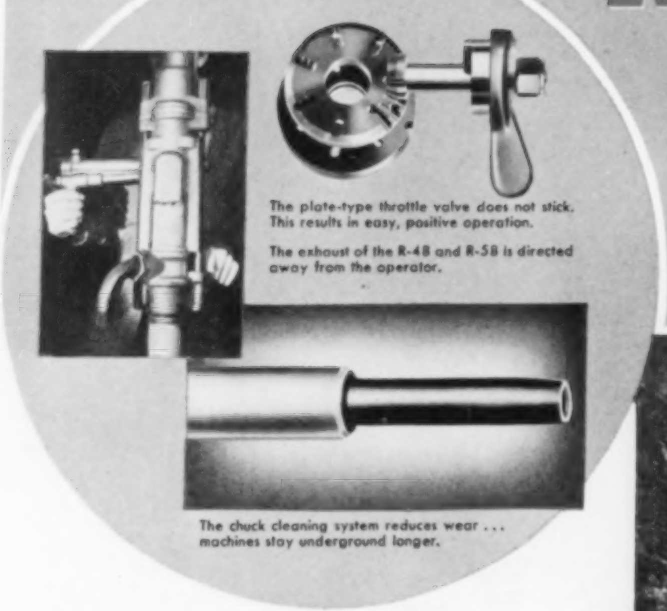
R-48 and R-58 Features that Make STOPING Easier



The plate-type throttle valve does not stick. This results in easy, positive operation.

The exhaust of the R-48 and R-58 is directed away from the operator.

The chuck cleaning system reduces wear . . . machines stay underground longer.

The Ingersoll-Rand R-48 and R-58 Stopehamers are built upon the principle that the machine should do the work . . . not the man.

Performance records everywhere prove that their easy-handling makes skilled miners even more productive. Some of the features that make stoping easier and that will enable your men to mine more ore are:

1 LIGHTWEIGHT— The R-58 weighs 116 pounds and the R-48 98 pounds. Each of these Stopehamers is lighter than other machines in its class.

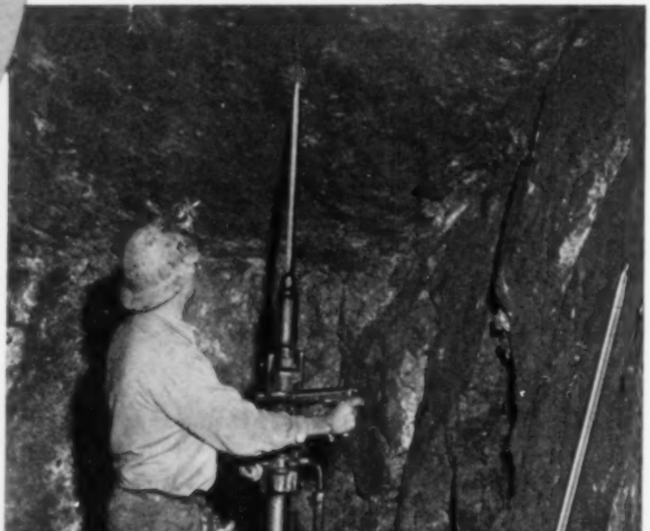
2 BALANCE— The center of gravity is such that the machine assumes a natural drilling position when picked up. This facilitates raising the drill to any operating position.

3 EXHAUST— The exhaust is located on the side of the cylinder opposite the operating handle. It directs exhaust air and water away from the operator and makes for easier handling.

4 SHORT OVERALL-HEIGHT— R-48 and R-58 are ideal for use in narrow, restricted stopes as well as in large stopes. Their short overall-height prevents top heaviness.

5 THROTTLE VALVE— The throttle handle facing towards the operator is easy to reach. It requires only an 80° turn for full opening. A half throttle position facilitates "collaring" because the piston then actually runs at only half speed.

6 FEED-LEG CONTROL— The feed control on these two machines is superior to any ever put on Stopehamers. It permits many fine variations in feeding power under all drilling conditions.



An R-48 Stopehamer producing vital ore in a western metal mine.

Ingersoll-Rand
11 Broadway, New York 4, N. Y.

5-448

COMPRESSORS • TURBO BLOWERS • AIR TOOLS • ROCK DRILLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

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With the new Westinghouse Buying Data, you can select and purchase the proper motor control in half the time.

Data, as presented, is striking in its newness. It's easier to read, easier to understand, and easier to use than any published previously by any manufacturer.

Chances are—if you are a buyer of motors and controls—that you have already received a copy of this new Catalog 7000 by mail. However, if you have not received your copy, write, wire or phone your nearest Westinghouse district office. (Requests will be filled through district offices only—no mailing from Westinghouse headquarters at East Pittsburgh.) J-21309

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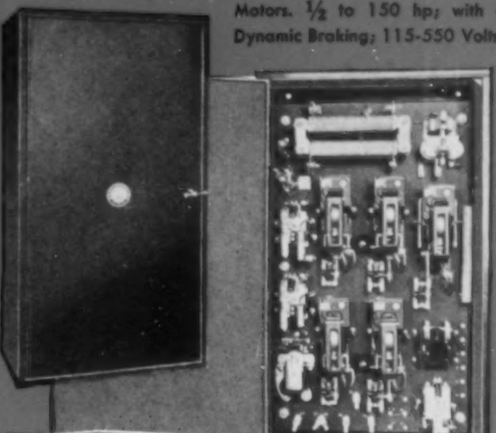
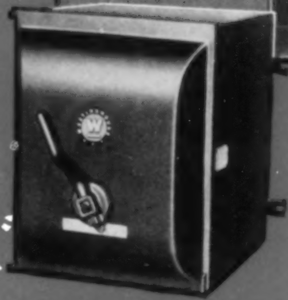
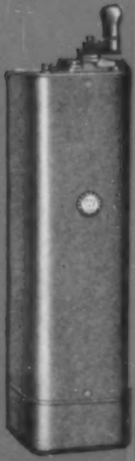
Motor Control



Heavy-Duty Reversing D-C Magnetic Timestarter for Constant and Adjustable Speed Motors. ½ to 150 hp; with or without Dynamic Braking; 115-550 Volts.

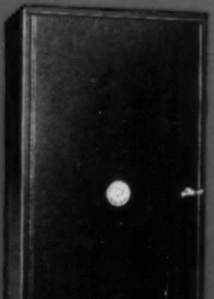


Manual Nonreversing Starting and Speed Regulating Rheostat for ¼ to 150 hp Applications. 32-550 Volts D-C.

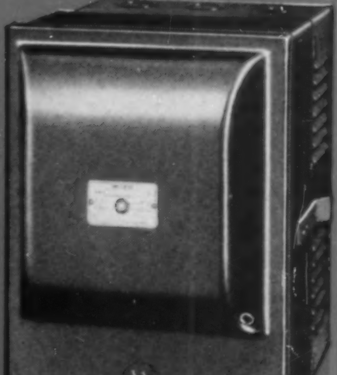


Reversing Drum Controller for Crane and Hoist Service, 1 to 50 hp; 115, 230, 550 Volts D-C.

Nonreversing "De-ion" Linestarter for Compound-Wound D-C Motors. 1½ and 2 hp; 115 and 230 Volts.

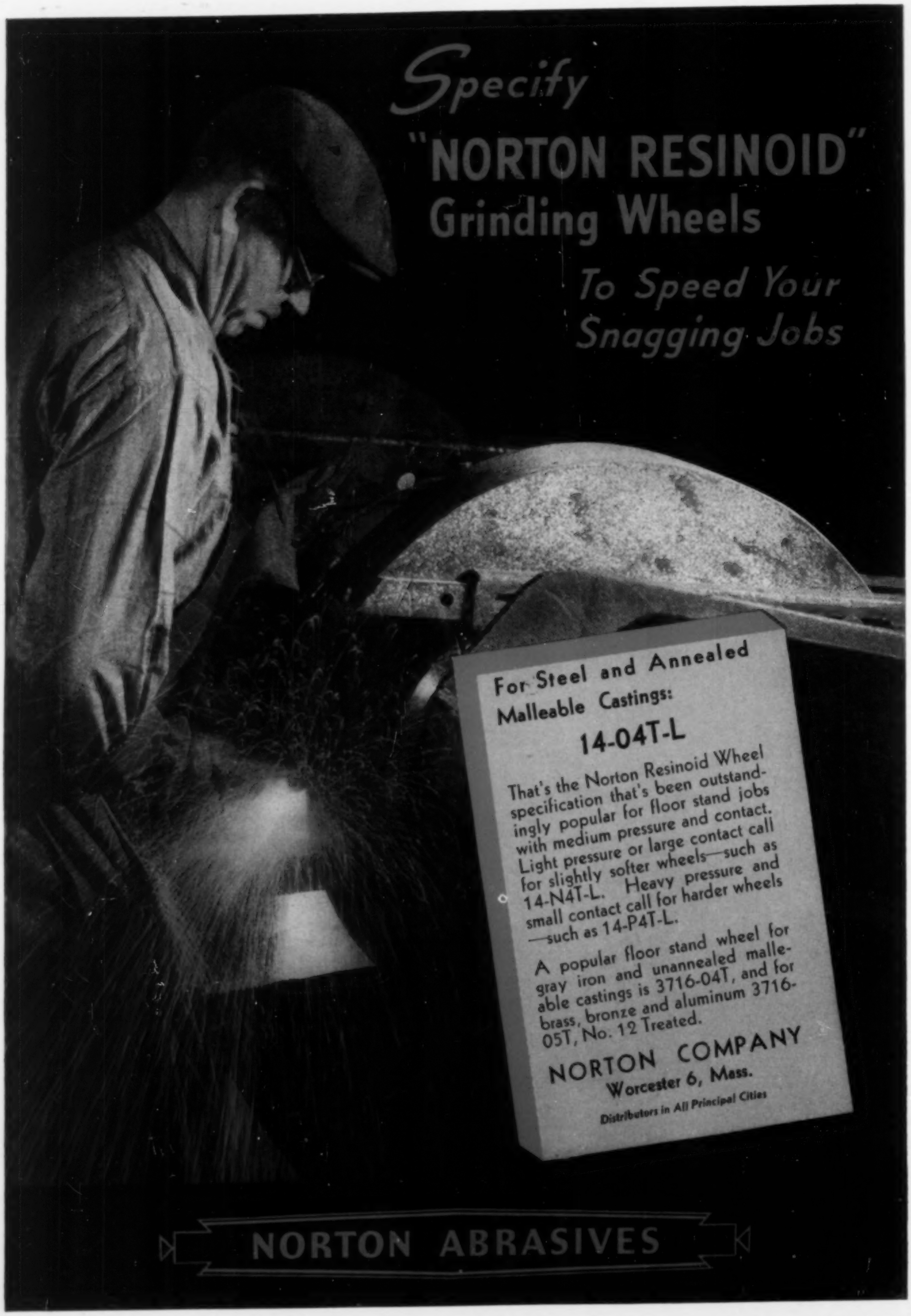


Heavy-Duty Nonreversing D-C Magnetic Timestarter for Constant and Adjustable Speed Motors, with or without Dynamic Braking. ½-150 hp; 115-550 Volts.



D-C General Purpose Nonreversing Magnetic Timestarter for Time Limit Acceleration. ½-10 hp; 115 and 230 Volts.

Reversing "De-ion" Linestarter for Compound-Wound D-C Motors. 1½ and 2 hp; 115 and 230 Volts.



Specify

"NORTON RESINOID" Grinding Wheels

To Speed Your Snagging Jobs

For Steel and Annealed Malleable Castings:

14-04T-L

That's the Norton Resinoid Wheel specification that's been outstandingly popular for floor stand jobs with medium pressure and contact. Light pressure or large contact call for slightly softer wheels—such as 14-N4T-L. Heavy pressure and small contact call for harder wheels—such as 14-P4T-L.

A popular floor stand wheel for gray iron and unannealed malleable castings is 3716-04T, and for brass, bronze and aluminum 3716-05T, No. 12 Treated.

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NORTON ABRASIVES

BUY CHRISTMAS SEALS
PROTECT YOUR HOME FROM
TUBERCULOSIS

ON THE COVER

MORE picturesque than most modern mechanical creations are the windmills of Europe, which date from the twelfth century. Because the wind gives up its energy without cost, thousands of these mills remain in service in an age of steam, electricity, and internal-combustion engines. The example illustrated has warped radial arms the better to catch the wind's force. Canvas is stretched over their metal frames, and the area covered is automatically increased or decreased to regulate the speed according to the wind velocity. The picture is reproduced from a photograph by Barbara Green from R. I. Nesmith & Associates.

●

IN THIS ISSUE

ALTHOUGH welding has replaced riveting to a great extent, it has also given rise to so many new applications for air-driven tools that its over-all effect has been to increase their use in industry. Our leading article, which traces Northern Ordnance Incorporated's outstanding record in war work, shows how pneumatic tools serve as accessories in typical welding operations.

●

SIX times during their hectic history, the lead-zinc-silver mines of 2-mile-high Leadville, Colo., have been dewatered expensively by pumping. Now the Bureau of Mines is driving a tunnel beneath the heart of the mineralized area to permanently drain it to that level. See page 280.

●

THE Liberty Ship has been this war's truck horse of the sea, carrying millions of tons of vitally needed supplies to the far corners of the earth. One firm, located 600 miles from tidewater, has built the propulsion engines for one-third of our entire Liberty fleet. The story of this accomplishment begins on page 286.

Compressed Air Magazine

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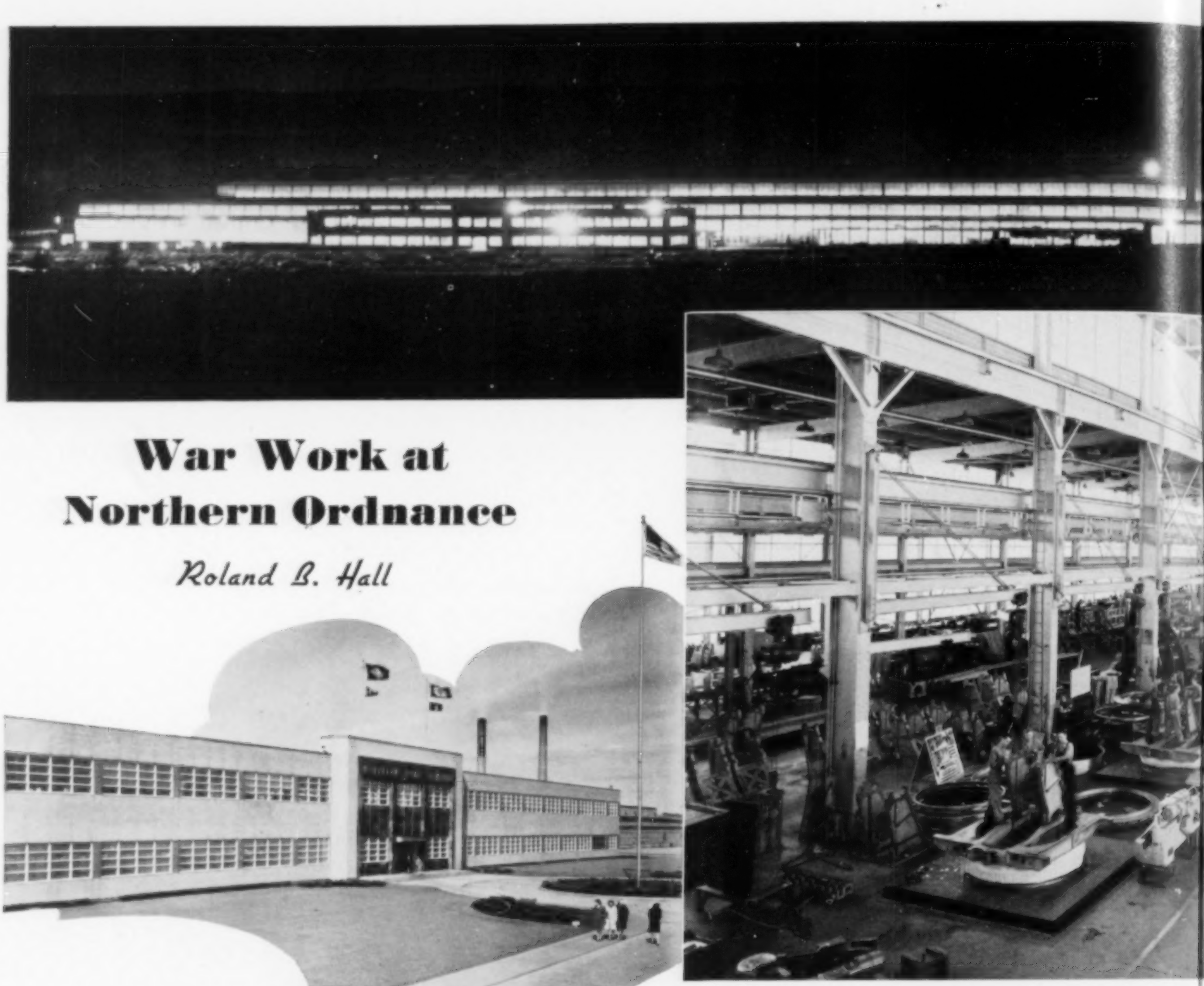
War Work at Northern Ordnance

Roland B. Hall



PLANT AND PRODUCT

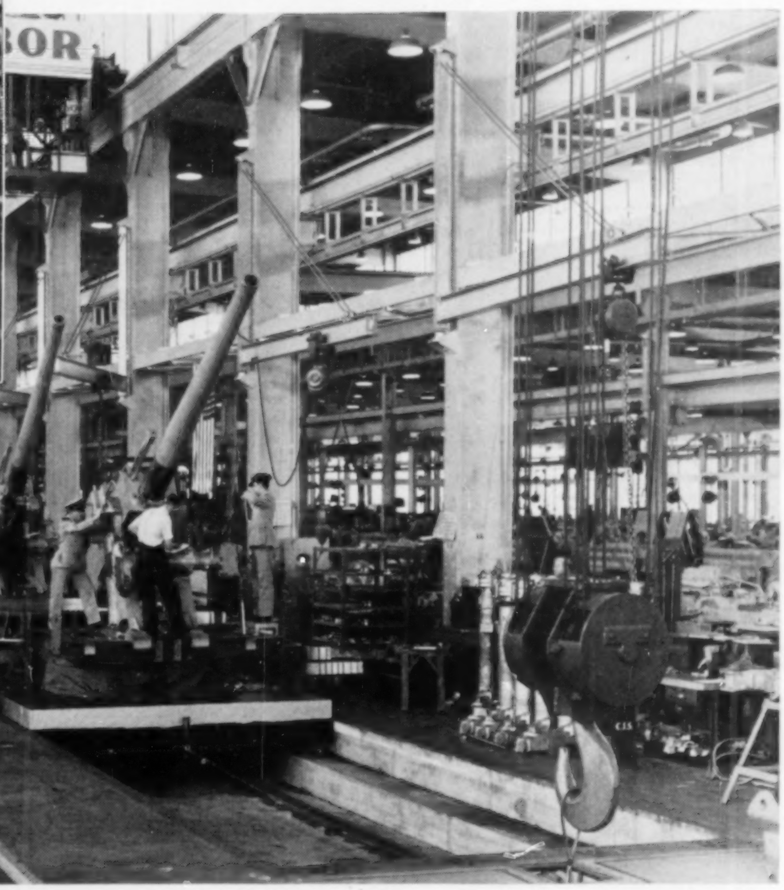
The war has caused Northern Ordnance Incorporated, offspring of Northern Pump Company, to become the largest industrial employer in the State of Minnesota. Pictured above are the entrance to the administration building and a night view of the shops where vital naval munitions are turned out. A section of the assembly floor (center) shows gun mounts in various stages of completion. Aboard a transport, somewhere at sea (upper right), one of the 5-inch guns built in its plant serves as a background for religious services conducted by a chaplain. Final assembly of the guns takes place on carriages (lower right) drawn by an overhead crane (note hook at lower right). Here, as in the case of all the manufacturing steps, everything is under the watchful eyes of inspectors of the Bureau of Ordnance, U. S. Navy.

WORLD WAR II has demonstrated the tremendous striking power and strategic importance of naval warfare to the complete satisfaction of even the most conservative "armchair admiral." Perhaps nothing can typify the role of the American way better than the growth and modernization of the U. S. Navy and the key industries which made this amazing strength available in record time.

Warships, basically, are the means by which naval guns are brought to bear on enemy targets. The design and production of naval guns is obviously of vital importance to sea supremacy, and it is interesting that one of the world's largest makers of naval ordnance is located inland remote from salt water. What was a 400-acre field of corn on the banks of the Mississippi in October, 1940, now marks the site of the expansive, ultramodern plant of Northern Ordnance Incorporated. It is on the outskirts of Minneapolis, Minn., and is called with pardonable pride by the top men "the world's finest machine shop." Northern Ordnance Incorporated is the wholly owned subsidiary of the Northern Pump Company.

Known before Pearl Harbor as a small manufacturer of hydraulic pumps, this ordnance maker extraordinary has had conferred upon him every superlative adjective in the vocabulary of the nation's war leaders. Red tape and conventional methods have been ignored at Northern Ordnance to make way for the men who know how to get things done. The Bureau of Ordnance, U. S. Navy, has long since become accustomed to the production miracles accomplished there, and has wholeheartedly coöperated in a manner that has made the plant the finest of its type. The factory stands as a model of efficiency, as an evidence of what private enterprise can achieve. The meteoric growth and success of the company is due in large measure to its energetic, resourceful president, John B. Hawley, Jr., whose leadership and vision are a saga of modern industry.

The naval ordnance rolling off the plant's production lines includes 5-inch, 38-caliber and 3-inch rapid-fire, dual-purpose gun mounts; electric-hydraulic elevating and training gear for larger



weapons of different sizes; electric-hydraulic drives for torpedo-tube mounts; powder and projectile hoists; and pumps for various hydraulic systems and for emptying flooded ships' bulkheads. Northern Ordnance Incorporated builds everything but the barrel and breech mechanisms of the rapid-fire guns.

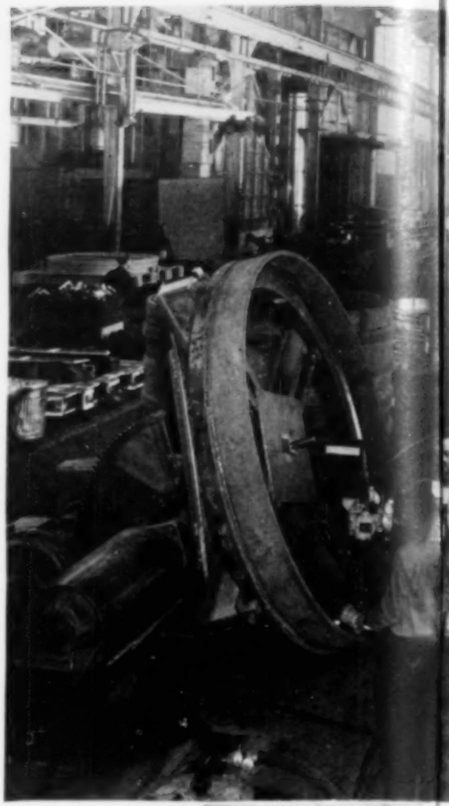
In addition, with its complete engineering and manufacturing facilities, it makes many of its own machine tools, fixtures, and special equipment. The production score becomes even more fantastic when it is taken into account that each of the 5-inch guns—just one of the many complicated items turned out—comprises approximately 50,000 parts, many of them machined to split-hair accuracy. It is an unforgettable thrill to sit on the gun-trainer's seat of one of these weapons, whirl the double hand crank with a touch of the finger, and feel the 17-ton carriage spin smoothly beneath you as the barrel moves ominously in a steady arc. A separate mechanism is used to elevate and depress the barrel with the precision of a Swiss watch. Designed as an all-purpose gun, it can be elevated for slapping down high-flying aircraft or depressed to a point below the horizontal so as to bear on surface craft and submarines.

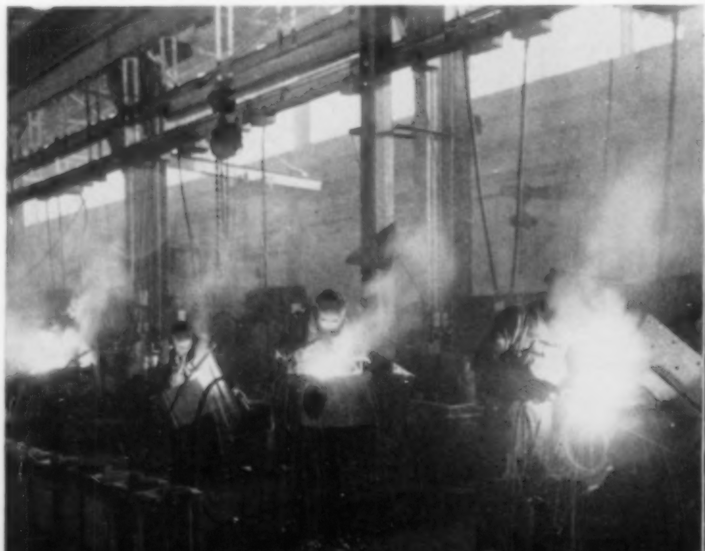
Construction of the plant was rushed as soon as preliminary plans could be drawn, and some machine tools were actually in operation 30 days after grading work had begun. One-eighth of a mile of shop structure was built in ten days. In November, 1940, a heavy blizzard made most folks duck for cover, but the construction crew stuck on the job and worked through the bitter storm, catching sleep in 4-hour shifts in sheds, while food and supplies were brought in through deep snowdrifts.

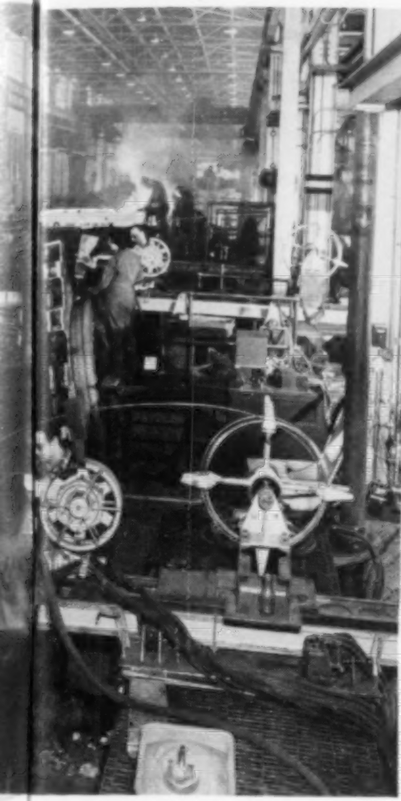
During March, 1941, frozen soil considerably delayed the laying of floors and the installation of piping and other equipment. Coke fires were built to thaw the ground, but this was tedious and also generated clouds of objectionable smoke and gas. Northern Ordnance engineers then got on the job and came up with an idea that did the trick in a few hours. They took lengths of steel culverts, 4 feet in diameter and 8 feet long, cut them longitudinally into two semicircular sections, and placed them on the ground. Into these covered areas they sprayed fuel oil by means of an oil burner with air at 100 pounds pressure, creating an inferno of heat. Batteries of these defrosters were used, the high temperature evaporating much of the moisture and eliminating the mud caused by the other method. It was found that four hours of this treatment was sufficient to thaw the soil to a depth of 2 feet.

The parent company of the present firm was the Northern Fire Apparatus Company founded in 1907. This Minneapolis concern sold pumps and light fire-fighting equipment, merging in 1913 with the smaller Pagel Pump Company to become the Northern Pump Company. John B. Hawley, Jr., a prolific inventor, entered the firm in 1926 while still in his early twenties, bringing with him a brief case bulging with his patents. Under his eventual leadership the Northern Pump Company began the production of hydraulic equipment and related items for the U. S. Navy in 1932. As Navy contracts mounted under national-defense stimulus, the company expanded; but, finding its factory still too small, sold it to General Mills. Ground was broken at Fridley, just north of the Minneapolis city limits, for the modern war plant which, today, represents a total investment by Hawley and the U. S. Navy of some $25,000,000.

Moving bag and baggage from the old establishment was a herculean task. It had to be done in secrecy because of the confidential records and priceless machinery. Equally vital was the need of careful planning to avoid loss of production man-hours. The job was begun one noon early in January, 1941, with tense excitement. Every piece of machinery from a massive boring mill to a typewriter had been catalogued and labeled with the building, room, and location it was to occupy in the new quarters. During ensuing hours, diesel-electric locomotives shuttled trainloads back and forth under heavy guard, operators accompanying machines to supervise handling. Flat cars carried the equipment from the old directly into the new plant, where a well-organized battery of cranes picked up each piece and swung it into its new position. By early morning, machines were turning







WELDING OPERATIONS

The plant's welding operations compare favorably in both scope and skill with any in the nation. The view at the lower left shows part of an arc-welding line where the work is firmly held in sturdy fixtures that can be rotated and tilted, making all joints accessible. Next to it is a close-up of such a fixture. At the top, left, is pictured the Unionmelt process by which the wire rod is fed from a reel. The entire welding process takes place beneath a granulated material which has the trade name of Unionmelt. Every inch of the welds is inspected by the magnaflux method, as seen above.

over on test runs. Exactly one-half day had been lost!

Like an immaculate officer standing at attention before his column of troops, the administration building, flanked by landscaped grounds, heads the six shop bays, each a quarter of a mile long. Impressive are the seemingly endless lines of shining machine tools shaping precision parts—the long rows of welding, assembly, chipping, grinding, and kindred operations. Of the most modern industrial design, the buildings are exceptionally well lighted. Both shop and office structures have immense areas of glass, as a result of which the interiors are almost as light as open spaces. This has been of importance in keeping accidents down to a minimum and also assures the vision so essential to accurate machine work and the rapid handling of materials. Nearly 8 miles of broad "streets," with names such as Broadway and MacArthur, connect all buildings. Hundreds of employees on bicycles and jitney trucks scurry about in the shops at all hours of the day and night. Visitors in the plant are immediately conscious of the fact that everything from the ground up is new; and crack maintenance crews keep the machines and equipment in top condition.

Northern Ordnance is famous for its innovations in practically every phase of production and manufacturing. Illustrative of this is the welding procedure. In the early stages of planning, welding was recognized to be an ideal means of fabricating naval-ordnance material and, as such, to merit special attention. In many factories, "welded design" means the use primarily of conventional joining methods, with welding entering into the last stage of construction.

At Northern Ordnance, a section of the engineering department has been set up to function as an integral part of the welding department. There the welding layout engineers devote all their efforts towards the design, tooling, and flow of fabricated parts for efficient production. There new or revised designs are broken down into component parts or subassemblies so as to simplify welding operations and to minimize the distortion of parts through expansion and contraction due to heat absorbed during welding and subsequent cooling. Purchasing and production men are assigned to the welding department to coördinate the delivery of materials with production schedules.

Fabrication is done at phenomenal speed by both manual and automatic welding methods. The procedure starts with the beveling of plates by gas torches, power saws, or by machining, as may be required, and continues with the welding of subassemblies until the unit is completed. In planning the welding, three principle considerations are taken into account:

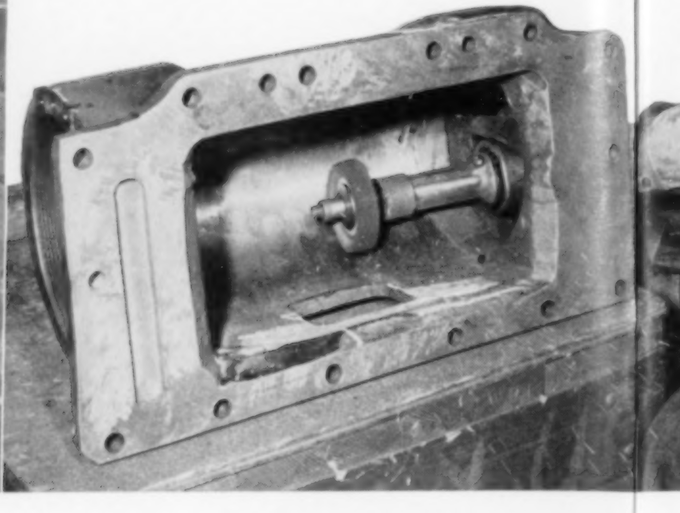
1- Uniform parts must flow smoothly to final assembly.

2- Distortion must be controlled and "locked-in" stresses avoided, warpage tolerance usually being held to plus or minus 1/8 inch, and even to 1/32 inch in some cases.

3- Joints must be obtained which will pass the rigid U. S. Navy and Northern Ordnance specifications which call for inspection by magnaflux of every inch of a weld to detect flaws. All welded areas subjected to high stresses are also examined by X-ray, permanent negatives being filed each with a number identifying the inspected and passed part in relation to the entire welded joint.

Metallic arc welding is the method most extensively used. The work is mostly done with 60-cycle alternating current, as this has been found to result in the highest-quality welds on heavy steel plates. These range from 1/2 inch to 3 inches in thickness and are usually joined in the flat position. Direct current is generally employed where welding is done in the overhead or vertical position and also for sheet-metal work. Other means and methods such as the Unionmelt, flash and resistance welding, as well as the oxyacetylene torch are used on certain metals or assemblies when it is of advantage to do so.

The first unit of a newly fabricated assembly or "weldment" serves as a model, and its progress is studied for possible improvements in assembly. Jigs and fixtures are utilized at nearly every step not only to speed the lining



up of parts and of welding but also to guard against distortion where warpage cannot be controlled by the welding sequence or by deforming the material beforehand so that it pulls into correct position during welding. Most jigs and fixtures are of uncommonly heavy construction to minimize distortion in the course of the work and to insure durability and precise alignment under severe service conditions.

As a further means of producing high-quality welds, it is standard practice at the plant to root chip and root weld all joints, the bottom side of a joint being called the "root." While firmly held in a fixture, a typical assembly is first welded from the top—that is, downward into the beveled edges of the two parts. The fixture is then rotated 180°, and a generous amount of nonfused metal is gouged out with an air-operated chipping hammer. After that, the welder deposits the final bead from the root side. This procedure usually requires elaborate jigs for accuracy and to make sure that all the work is accessible for welding and chipping.

In this manner each joint is welded from both top and bottom, resulting in a sound weld free from nonfused areas. The contour of the beveling, which is cut to insure adequate fusion between the parent metal and that of the welding rod, varies according to plate thickness and type of joint. The chipping of the root and the technique of depositing the bead are governed to a large extent by the beveling—the way in which the edges of the parts are prepared for welding. After an assembly has been welded, it may be necessary to straighten distorted parts by means of massive hydraulic presses. However, the straightening process usually induces additional "locked-in" stresses, and these are relieved by annealing in a large furnace at a temperature of 1175°F. With that done, the dimensions are checked for adherence to permissible tolerances.

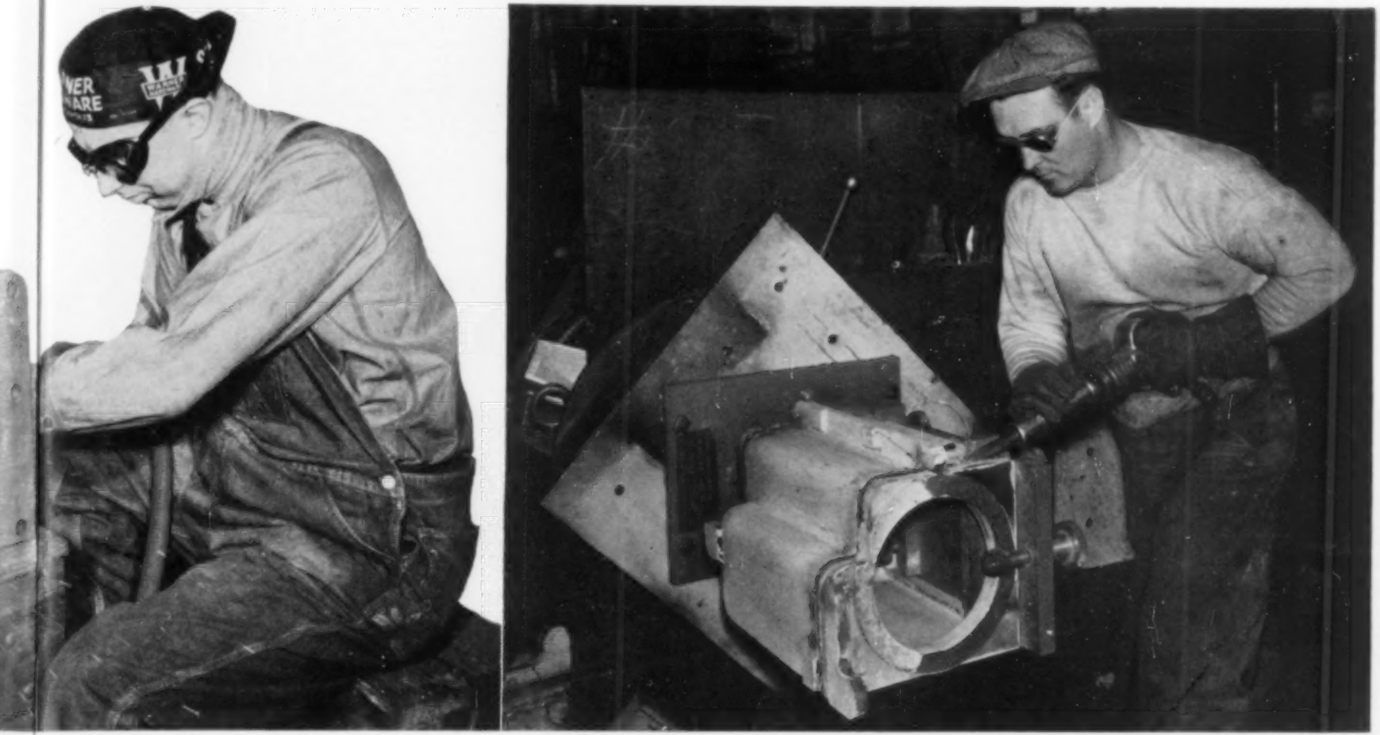
In designing the welding fixtures, Northern Ordnance engineers took every precaution to protect the operators from harmful rays and hot metal and arranged them so that they can usually work in the "downhand" position, which is the most convenient and least fatiguing one. This was accomplished by mounting many of the fixtures on rotating and tilting positioners, permitting welding and chipping to be done on both sides of a seam without unclamping the work. In some cases, an assembly is tack-welded before it goes on a fixture, while in others all welding is done on one set-up.

An interesting example of a welded assembly is a rammer tank for the 5-inch gun mount. This is an electric-hydraulic mechanism, the tank itself housing the pump and hydraulic fluid which drives the rammer spade which, in turn, pushes the shell into the breech of the gun for firing. This tank, as originally made, was a bronze casting weighing 158 pounds. When copper-bearing metals became critical, ferrous metals were substituted for large parts wherever possible. Northern Ordnance designers drew up plans for a welded-steel rammer tank that has worked out successfully and actually reduced the weight to 142 pounds.

From the company's own foundry and from more than 50 others flow castings for finishing and assembly into precision mechanisms, while hundreds of large and small subcontractors within the state and throughout adjoining states supply parts and materials of many kinds. Many of the castings are housings for hydraulic pumps and systems, and it is essential that they be freed of all traces of sand and loose metal particles which might otherwise become entrained in the hydraulic fluids. For this reason they are carefully finished by hand with pneumatic grinders. Size 3F surface grinders are extensively utilized for flat surface work; the lightweight Size 00 and other small grinders are used with cone wheels to smooth all corners and inner passages of intricate castings; while Sizes 2 and 3 are suitable for general-purpose cleaning of medium-sized castings.

The largest single application of compressed air is in the work of sand-blasting, which is done in specially designed rooms with air- and dust-tight doors and windows. Cleaning of castings and other parts goes on there continually. Next to the sand-blast rooms are spray booths where weldments are painted before delivery to the assembly sections. Second largest users of compressed air are the pneumatic tools, while the remainder of the consumption is accounted for by air chucks and fixtures, blowguns, painting, operation of direct-lift hoists, and many minor services.

The role played by pneumatic tools in the welding procedure is of particular importance. This is demonstrated by the great number of them in continual use while welding is in progress. Clean-



AIR-OPERATED TOOLS

Large numbers of pneumatic tools of several types are used throughout the plant. Each welder has a scaling hammer at hand for cleaning welds and removing excess spatter (extreme left). Hundreds of portable grinders are utilized for smoothing surfaces of castings many of which enter into hydraulic systems. It is therefore important that no sand or metal particles remain on them to be entrained later in the operating fluids (center). Chipping (above) is an essential step in root welding, and is done to gouge out unfused metal from the reverse side of an initial weld before depositing a root weld from that side.

ing of welds, root chipping, and grinding—all these operations had to be studied to determine the particular tool that would best do each class of work on a mass-production basis. Chipping hammers such as Sizes 200 and 300 serve to cut out nonfused metal prior to root welding. After the final bead is deposited, any excess metal is removed with chipping or scaling hammers. The welds are then further finished by grinding prior to magnaflux inspection.

Several thousand pneumatic tools are in service in the various shops at Northern Ordnance. Most of them are used in conjunction with welding and in the finishing of castings. In the welding bays alone, about 350 men work with chipping hammers and a like number with grinders. In addition, each welder has an air-operated weld-flux scaling hammer which he keeps handy for the removal of excess metal and spatter. Elsewhere in the plant are employed portable air-operated drills of several sizes to ream, tap, and drill work that is not accessible to or cannot economically be done by standard machine tools. Air at an average pressure of 100 pounds is delivered to the pneumatic tools, thus enabling them to develop the maximum power for which they are designed. They are kept in top condition in a well-equipped repair shop maintained close to the production lines. More than 150 Ingersoll-Rand direct-lift air hoists can be seen throughout the shops, particularly where heavy castings and weldments are moved on and off machine tools and fixtures.

Many of the welding fixtures require compressed air to actuate clamps, centering devices, chucks, skids, etc., in fact, the entire plant is served in countless ways by air supplied by a battery of stationary, duplex-type compressors totaling 3000 hp. All are driven by direct-connected, synchronous motors. Among the novel uses of compressed air is that of cooling a vertical fixture that holds a hollow cylindrical piece of steel in position for welding. The air is admitted through the bottom of the fixture and passes through a Venturi injector that induces a flow of the surrounding air which cools both fixture and work during welding. On another special fixture an air-actuated skid moves an assembly into place and holds it while mechanical clamps are adjusted and tightened. In still another instance, a foot-operated pedal controls an air valve which, when opened, actuates toggle clamps which firmly hold the assembly.

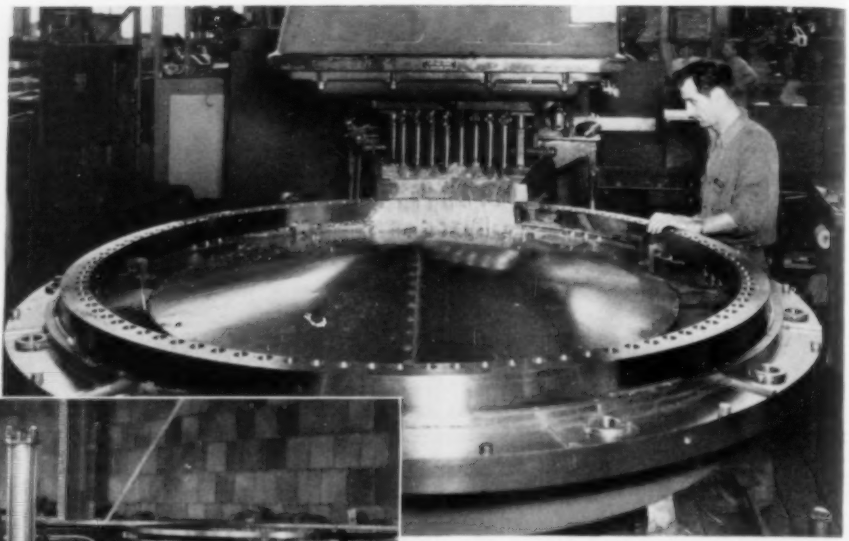
A novel but important use of compressed air is made in testing the hydraulic recoil mechanism of the assembled 5-inch guns and mounts. For this purpose a pneumatic cylinder with a long yoke is fitted over the end of the barrel, the yoke extending along both sides of the barrel to the gun carriage, where it is attached. A bushing in the cylinder snugly fits the barrel, which is slowly forced back as compressed air is admitted into the outer end of the chamber. When the piston has reached the end of its stroke, a valve instantaneously releases the air to atmosphere, thus allowing the barrel to snap back to its original position. In this test the recoil mechanism is subjected to stresses and pressures similar to those that would be set up under actual firing conditions.

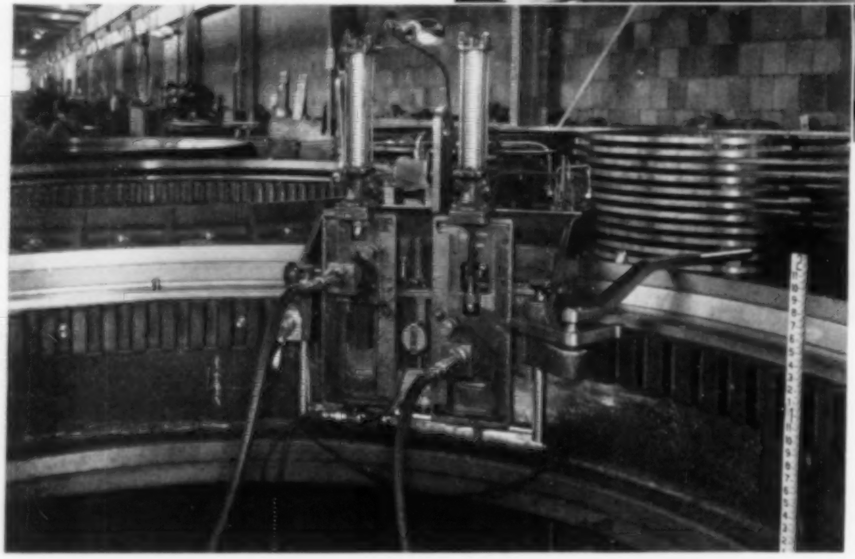
Certainly there can be few if any more spectacular displays of diversified machine tools than those in the bays at Northern Ordnance. Most of them were installed during 1940 and 1941—back in the days when the machine-tool industry was the bottleneck in war production. It is interesting to note that some of these machines were really destined for factories in Japan, Greece, France, and Belgium, but were reassigned to the Northern Ordnance plant where metric readings were changed to standard markings and offensive Japanese characters were obliterated.

Although most of the machine tools are used for conventional work such as turning, gear cutting, vertical and horizontal drilling, etc., there is an unusual number that has been adapted for the purpose of simplifying operations. From the time the first Navy contract was placed, pressure has been brought to bear on the production men to get the most out of their existing machinery. As a result, many a corner has been cut, and

SAVING MACHINING TIME

For cutting gear teeth on large-diameter rings for gun-mount bases, holes are drilled eight at a time, as shown at the right. The webbing is then cut out with a band saw to form outlines of the teeth. After hardening, the inner surfaces of the teeth are finish-ground. Two pneumatic grinders (below) are moved up and down by hydraulic pressure to cover the entire tooth surface equally.





set-up time and delays occasioned by shifting work from one machine to another have been reduced by designing tools to perform several operations that ordinarily were done by two or three.

For example, the engineering department has developed a method for the mass production of large internal gear rings used in gun mounts. Conventional practice would be to notch each tooth with a fine tool, stroke by stroke, but this would take many days. Northern Ordnance procedure does the work in a few hours! By it a series of gang-drilling, band-saw cutting, and boring-mill operations is substituted for the usual repetitive milling operations. Circumferential drilling of the large ring is done by a standard multiple-type drill and wheel jig that puts in eight holes at each setting. When this is completed, the gear blank is transferred to a band saw where the inner web left by the drill is removed. The amount of stock thus taken out is sufficient to permit form cutting of the gear teeth in a single pass.

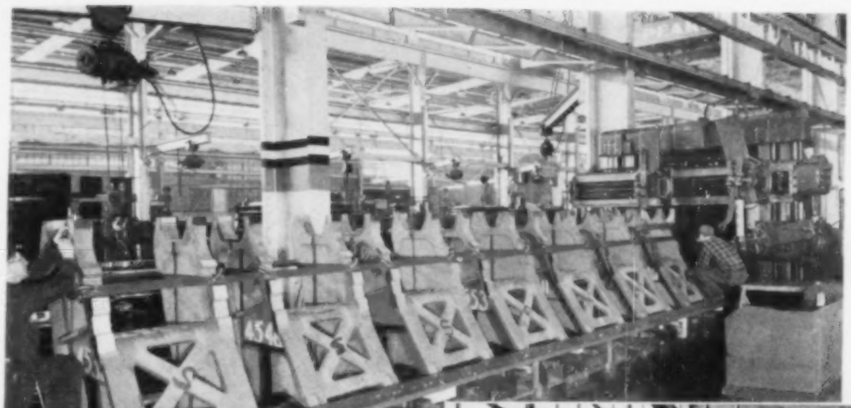
An accurate check on the indexing fixture adapted for the form milling of the internal teeth is maintained by a scribed circumferential tape wound around the flange of the main holding fixture and by a permanently located, graduated field microscope. Basic indexing is done by means of a standard pin-and-hole arrangement. However, before clamping the work and making the cuts, the lines on the tape are checked by the microscope. Graduation of the tape is done separately on a standard jig borer, the desired tooth-spacing chordal dimensions being determined and laid out in a flat plane prior to wrapping and sealing the tape to the fixture.

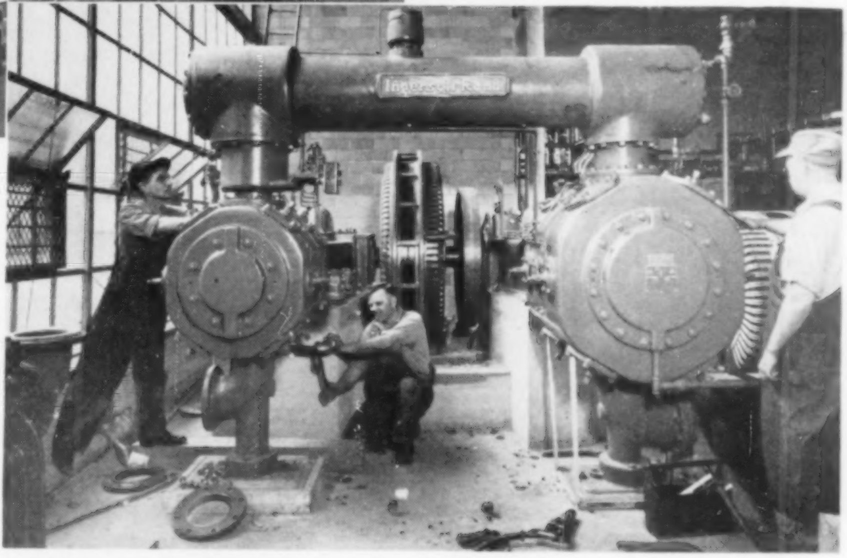
After hardening by electric induction, the ring is finish ground by two Size 1G portable pneumatic grinders which are held in a fixture and are lowered and raised automatically by hydraulic pressure to finish the inside tooth surfaces. It is then inserted in its housing member and set up on an adapted, obsolete boring mill for lapping-in in combination with the pinion with which it will be used on the gun mount. In another case, a vertical boring mill is equipped not only with the conventional type of tool for taking a cut on a large-diameter ring but also with finish grinders which are brought into position after the cut is made. Both top and inside circumferences of the ring are thus finish ground without its removal from the fixture.

In touring the plant, special equipment and unusual set-ups are seen at nearly every turn. There are many instances where a machine has been designed to overcome some difficulty experienced along the production line. For example, it was found that a goodly number of finished parts was being scrapped because drill bits and taps broke off during the final machining operations. The removal of these taps presented a real problem, which was solved with the accustomed resourcefulness. A small unit resembling a light drill press was designed for cutting out such taps by means of a carbon arc without damaging the part. The tool itself is a hollow copper tube which hops up and down on the stuck bit as soon as the machine is started. It is actuated by a solenoid so that the arc will not cause it to adhere to the work and can be lifted by hand while in operation to blow compressed air through it to clean the part. The bit is thus gradually burned out, and another piece is prevented from going to the scrap pile.

Again, time was saved by supplanting the hand marking of parts with a machine dubbed "Sarah Blitz" which is fed and operated by compressed air. Another unique machine presses bronze bushings into hollow pistons by means of compressed air. The pistons are fed onto a circular fixture, while the bushings are dropped in automatically from a vertical tube. Each piston passes under an air-actuated punch that forces the bushing into place, where it acts as a bearing for a connecting rod.

A novel idea is the system of giving every project a "father" who is responsible for a certain item and rides it through to completion. Foremen and shop superintendents have unusual independence in getting work through their divisions. Northern Ordnance hates red tape and anything resembling it. Management men don't write each other long memorandums and letters; they pick up a phone or talk it over at the central cafeteria and save days of delay.





COMPRESSOR AND AIR HOISTS
The picture below shows mechanics setting up one of the six Ingersoll-Rand duplex compressors that supply some of the air required throughout the plant. The machines discharge air at 110 pounds pressure, insuring its delivery to the tools and appliances at 100 pounds or higher. In addition to operating pneumatic tools, compressed air powers numerous air hoists. Several of them are seen in the view at the left. The one at the extreme left is setting in place one of seven weldments that will be planed in unison.

Taking all chances and risks, the company contracted to deliver gun mounts faster and cheaper than any other manufacturer. These and other promises have been met and bettered. It was among the first fourteen to receive as a group the Navy "E" for excellence in ordnance production and has since been awarded five stars for the continuance of meritorious service. The original presentation was made officially on August 22, 1941, when the working force numbered 3200. Today, Northern Ordnance is the largest single employer in the State of Minnesota. Employment in the plant reached a peak of 11,400 in December of 1943, an increase from 200 in the summer of 1938.

In studying the growth of this ordnance maker, it is hard to believe the figures which show that production and employment curves soared skyward at the same time. Thoughtful planning provided for additional buildings and facilities; but construction and installation of machinery was never allowed to hinder output. Small wonder that the Navy has admiration for this plant, for it is guns and more guns that speak the language our enemies can best understand. Northern Ordnance particularly pleased naval men when it turned out a submersible pump weighing 93 pounds that handles twice as much water as the Navy's best 400-pound pump.

The hundredth 5-inch rapid-fire antiaircraft weapon moved off the production line before the advent of Pearl Harbor. It was considered the world's finest "ack-ack" until the double-barreled model was designed. Manufacture of the twin gun began in January 1942. It swings on a wide circular base, provided with precision gears and roller bearings.

Northern Ordnance is famous for its diversified and successful production-boosting campaigns. The one that attracted most attention was that planned to promote the "twins" shortly after the first contract was received. The president of the company posted a cash prize of $1000 to be presented to the first man in the plant to become the father of twin babies. Signs reading "We Want Twins" appeared throughout the factory, and word soon spread throughout the Twin Cities. Interest was keen, and grew from week to week, especially on the part of "expectant" fathers. After two months, a night-shift coffee brewer copped the prize by crashing through with twin boys. In addition, Mr. Hawley gave a $100 war bond to each youngster.

Enthusiasm at the plant was particularly high when it was announced early in 1942 that Number 3 gun on board the destroyer *Ward* had sunk a Jap submarine near Pearl Harbor on December 7, 1941. That gun was a Northern Ordnance product and was the first to fire a telling blow in the war against Japan. Among the many reasons for the ideal employee morale is the decentralized method of providing hot meals at all hours. Mobile kitchens, each provided with a butane-gas system to keep food piping hot, are wheeled into all areas of the shop, permitting workers to save a great deal of their mealtime for rest and relaxation. All food is served at cost, and the company actually loses a tidy sum on it in the course of a year. Free coffee is supplied day and night. Providing meals throughout the plant is a gigantic task, and the efficiency with which it is accomplished is proved by the fact that approximately 7000 workers are taken care of in seven minutes.

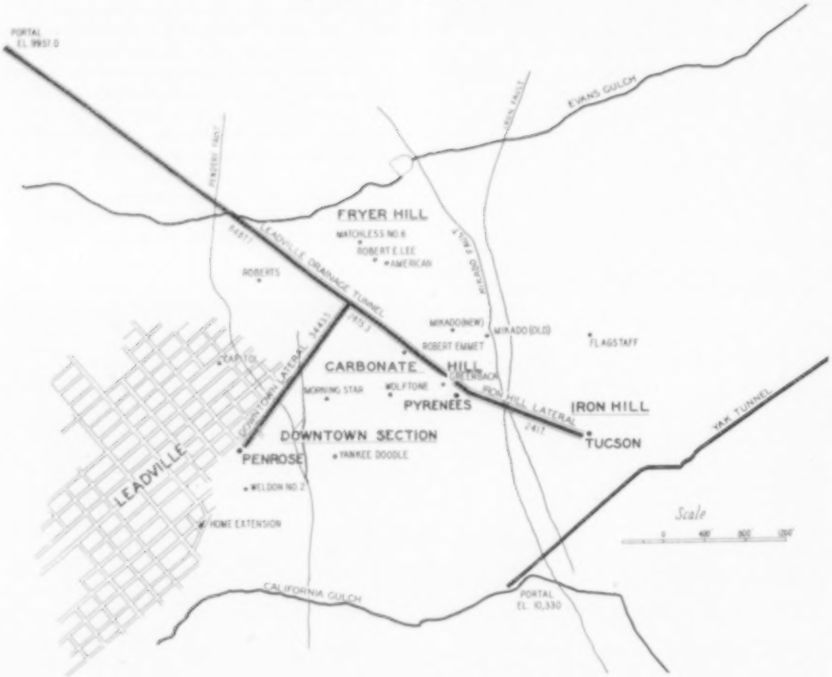
Recreational fields are available for softball and volley ball, and bowling leagues are sponsored in addition to many other activities. Before shotgun shells became scarce, more than 1000 of the employees sharpened their shootin' eye regularly by taking advantage of the trapshooting and skeet ranges. Minnesota is well known for the fine sport ducks and pheasants offer the hunter.

To meet the transportation crisis, the company bought a number of the big World's Fair buses. Subsequently, it took over the trackage of the Minneapolis, Anoka & Cuyuna Range Railway and installed streetcars which run to and from the plant at frequent intervals to connect with the city transit lines about 2 miles distant. Identification badges serve as fare.

Our success in carrying the offensive to the enemy is attributable in great measure to the men and women of such industries as Northern Ordnance Incorporated, which has spared no effort to insure final victory.

Leadville Drainage Tunnel

Allen S. Park



THE TUNNEL'S COURSE

A plan sketch, showing the line of the bore and the length in feet of its various sections. It is expected to drain the four principal mining areas to a depth that will eliminate pumping in many of the mines and greatly reduce its cost in others that already extend below the tunnel grade. Also indicated is the course of a section of the Yak Tunnel which was begun in 1895 and has made possible the extraction of some 80 million tons of ore from the part of the district that it drains.

FROM three to four million tons of zinc, lead, and manganese ores that are now underwater can be economically extracted upon the completion of a drainage tunnel being driven at Leadville, Colo. The drainage project, which is being directed by the U.S. Bureau of Mines, is expected to restore activity in many of the old mines and to revive the 2-mile-high camp whose 75 years of existence have been marked by alternating periods of prosperity and depression. Tunneling operations were begun last December and are scheduled to be completed about next July.

The ore-bearing area at Leadville may be roughly divided into a western district, where base metals predominate, and an eastern one, which yields considerable quantities of gold and silver in addition to base metals. The eastern district is partially drained by the Yak Tunnel and has been the scene of virtually all the mining work done in recent years. The new bore is designed to withdraw water from the western district, which has accounted for approximately 80 percent of the past output. The latter has four principal ore-bearing subdivisions: Fryer Hill, Carbonate Hill, Iron Hill, and the Downtown section, with differing elevations both on the surface and at the ore horizons. Each of them is considered to be a separate water basin.

The tunnel is being driven in a southeasterly direction from a portal located on the East Fork of the Arkansas River and at an elevation of 9957 feet. It will follow a straight course for a distance of 11,363 feet to the vicinity of the Pyrenees Shaft, and from there it is planned to extend it 2417 feet on a slightly different line to the Tuscon Shaft. At a point 8488 feet in from the portal it is proposed to drive a lateral 3444 feet to the Penrose Shaft in the Downtown section. Three short laterals totaling 332 feet are planned to the Hayden, Robert Emmett, and Pyrenees shafts. These connections will expedite drainage of the underground workings, improve ventilation, and provide access to the tunnel. The total proposed length of the bore is 17,556 feet, or about $3^1/_3$ miles. However, it may be possible to resume production from some of the intermediate territory before the tunnel is completed, and there is also a chance that underground drainage connections between the various basins may be such that the water table will be lowered to the tunnel level without extending the bore to its projected terminals.

Ever since mine shafts have penetrated deep enough to determine that the entire underground structure is water-soaked, it has been realized by expert mining men that the most economical course would be to drive a horizontal drainage channel to cut the ore-bearing rocks well below the surface. Numerous schemes for doing this were advanced, but nothing came of them until the war created an urgent need for the zinc and lead ores that are known to exist in scores of workings that have been inundated for many years.

Up to now the water has been pumped to the surface only when the mines were producing. If mining operations had been conducted continuously, this procedure, although costly, would have sufficed to keep the workings dry. However, unfavorable metal prices, labor troubles, etc., have occasioned numerous interruptions, and during these periods of inactivity the pumps were pulled and the mines quickly filled with water. Whenever it was desired to resume operations, it was necessary to pump out the accumulated water so as to make the lower workings accessible, and this was not only expensive but also took so much time that the mines sometimes did not get back into production soon enough to take full advantage of temporary good markets for their metals.

That there was need for pumping was evident almost as soon as underground mining started. This did not take place until 1874, although metal was discovered in nearby California Gulch in 1859. That was placer gold, however, which was recovered by sluicing the gravels. The settlement that grew up was called

MINES, OLD AND NEW

The Little Pittsburgh and the Matchless are two of the old properties that greatly influenced the bizarre career of H.A.W. Tabor, who rose to riches and affluence but died a poor and discomfited man. As a storekeeper, he grubstaked prospectors August Rische and Theodore Hook in 1878. They discovered the Little Pittsburgh (bottom view), so named because Rische had been an iron puddler in Pittsburgh, Pa. Tabor and Rische bought out Hook, and Rische afterward sold his interest to David H. Moffat who later financed the Moffat Railroad. The Matchless (below) was Tabor's favorite mine. When his financial house crumbled, he managed to save it, and before he died admonished his wife never to part with it. She hung on tenaciously, and spent her final years in a shack on its premises. Left, is the mill of the Resurrection Mining Company which operates several mines through the Yak Tunnel and controls others that will very likely again produce when the drainage tunnel has unwatered them.

Photos by T. J. Barbre

Oro City, and in 1861 it was the largest community (5000 population) in the territory. A few years later the region was practically deserted, but a new and greater era of activity commenced in 1874 when W. H. Stevens found silver-lead ores. Feverish prospecting ensued, and many claims were located. Large quantities of ore began to come from the ground, and mining became highly profitable when smelters were established. The town was organized and given its present name in 1878. Two years later, when the tracks of the Denver & Rio Grande Railroad reached the district, it numbered 35,000, of whom 15,000 were in Leadville proper. In that year there were 30 mines, with an output of $15,000,000 in gold, silver, and lead, and ten smelters. Leadville was acclaimed the greatest silver camp in the world.

Leadville has produced more mineral wealth than any other camp in Colorado and ranks sixth in output among all the nation's mining districts. The Bureau of Mines credits Lake County with a yield of $458,922,866 to January 1 of this year, and virtually all of it came

Photo by W. H. Lehr

HEADING VIEW

A picture taken during the early stages of the work, showing spiling driven at the sides and top of the bore and breast boards used at the face to hold back the wet, loose ground that impeded progress for several months.

from Leadville. However, less than $30,000,000 of it has been produced in the past twenty years, primarily because of the depressed prices of lead and zinc.

One of the earliest pumping operations was carried out in the Robert E. Lee Mine, which became flooded while paying dividends of $90,000 a month. J. Y. Marshall, head of the operating company, commissioned D. W. Brunton, then a young mining engineer, to install equipment to unwater it and told him he could name his own price for his services. Brunton speedily procured pumps and set them up. On the day they were put in service, Marshall had open house at the mine, with champagne and cigars for the camp's elite and "beer and smokes" for the miners. It so happened that Marshall was a candidate for district judge at the time and was ushered into office by a goodly surplus of votes. The Robert E. Lee on Fryer Hill is one of the old properties that are expected to become producers again when the tunnel starts functioning.

Each mine originally did its own pumping, but this involved the duplication of equipment and resulted in many inequalities. The deeper mines received the drainage from their shallower neighbors and were forced to handle it, whether they liked it or not. Thus, Tom often did the pumping for Dick and Harry, and in the long run the mines in the lower-lying areas bore the lion's share of the expense involved. Later on, joint pumping enterprises were inaugurated, especially after periods of nonproduction when all the mines were flooded.

Prior to 1933, when all underground activity ceased in the western section of the Leadville mining district, the four basins were unwatered seven times by pumping campaigns. Up to 1911, when pumping was stopped, partial drainage of Carbonate Hill was maintained down to the bottom of the Wolftone Shaft. The shaft was again unwatered in 1915, but all pumps in the basin were shut down in 1919, when labor troubles closed the mines. Between 1923 and 1925, the water was again pumped out and mining operations were conducted until 1931, when a disastrous slump in metal prices caused a shutdown. The mines have since remained flooded. The total cost of pumping in the Carbonate Hill area during the period of 1915-31 was about $1,300,000.

The mines of the Fryer Hill area were unwatered in 1901 and worked until the depression of 1907. They were again pumped out through the Harvard and Jamie Lee shafts in 1915 and worked until 1918. No further pumping has been done in that area save in the case of some small mines west of Fryer Hill, where the water level was lowered 50 feet during the period of 1936-40 to give access to some manganese ores.

In the Downtown area, a pumping campaign that was begun in 1896 and completed in 1898 is reported to have cost $1,500,000. In the latter year, the mines of the area were disposing of 15,000,000 gallon of water per day at an annual pumping cost of $915,000. The 1907 depression closed the mines and they were not again unwatered until the outbreak of World War I brought a higher price for zinc (it rose from 7 cents a pound to 27 cents in 1915). The Downtown Mines Company was then organized to reopen several properties, which were produced through the Penrose Shaft. The bottom of the shaft was reached in July, 1916. The cost of pumping averaged $5000 a month, and the total cost to the time the project became self-sustaining through ore production was $540,000. The mines were closed by the labor troubles of 1919 and have been idle since then. The Penrose Shaft was again partially dewatered in 1929, but the financial depression that followed caused abandonment of the undertaking before it was completed.

The Yak Tunnel, which was begun in 1895, has materially reduced the cost of draining the Iron Hill area. The greater portion of the ore produced from Iron Hill has been mined from workings that extend 780 feet below the tunnel. The lower levels of these properties have been flooded since 1924. As the bore now being driven is more than 300 feet lower than the Yak, it will greatly facilitate the unwatering of this ground.

There is still a lot of zinc at Leadville, because sphalerite, the sulphide, was long an unwanted mineral, while the carbonate ores that existed in abundance were not recognized for many years. Lead and silver prices were favorable from 1879 to 1919, and these metals, along with gold, were responsible for the bulk of the production prior to the turn of the century. Missouri, Kansas, Oklahoma, Wisconsin, and Virginia dominated zinc mining up to 1899. Leadville shipped sphalerite to the Kansas smelters, but they objected to it on the score that it was hard to treat because of its iron content, some of which was in chemical combination. Also, Tri-State ores contained about 60 percent zinc, whereas the Leadville ores had a concentration of only 45 to 55 percent. On top of this prejudice was the fact that it cost $12 a ton to deliver Leadville ores to the Kansas reduction works. The result was that sphalerite remained in the Leadville mines or, if hoisted, was put over the dumps.

The Wilfley concentrating table was brought out in 1895 and proved a boon to Leadville. It yielded a concentrate that was passably acceptable to the smelters, although it is no secret that the Kansas reduction plants to this day prefer to treat Tri-State ores. However, by 1899 sufficient concentrating capacity was available at Leadville to handle most of the sphalerite produced there, and from that time on this ore yielded profits whenever zinc prices were favorable. The advent of selective flotation likewise proved of inestimable benefit to the district, as it made it possible to segregate the various minerals. The present practice is to make separate zinc, lead, and iron concentrates, all of which can be satisfactorily treated by the smelters.

The territory that the tunnel will drain has not been worked since 1933, and virtually all production in the past decade has come from the eastern part of the mineralized area and from old mine dumps. The 1943 output (Lake County) had a value of $3,188,029, and was the largest since 1926, when production was worth $4,104,615. The values of individual metals obtained in 1943 were: zinc, $1,345,265; gold, $793,625; lead, $739,408; silver, $272,291; copper, $37,440. These figures represent sizable increments over 1942 for all metals except gold, which declined 17 percent. The rise in lead (49 percent) and zinc (78 percent) was attributable to increased operations by the Resurrection Mining Company and to the starting up in July of a "sink-and-float" mill of 1000 tons daily capacity by the Ore & Chemical Company.

The Resurrection Mining Company, biggest lead and zinc producer in the county, was incorporated in 1938 and is owned in equal proportions by the Hecla Mining Company, the Newmont Mining Corporation, and the United States Smelting, Refining & Mining Company. It acquired the Yak Tunnel and some of the mines served by it, and also constructed a 250-ton flotation mill that was enlarged during 1943 to 600 tons daily capacity. Last year it recovered 2500 tons of lead and 3875 tons of zinc, mostly from newly mined ore. For the past several years the company has been buying up various old mining properties throughout the Leadville district, and it will be in a position to conduct large-scale operations after the drainage tunnel is driven.

The sink-and-float or heavy-media mill of the Ore & Chemical Company is the second of its type built in Colorado, the first one being designed to handle fluorspar. By this process, ferrosilicon of -65 mesh fineness is maintained in suspension in a solution, and the ore is fed into it. Light-weight waste rock floats on this high-density medium, while the heavier mineral sinks, and rough separation is effected. A concentration ratio of 7½ to 1 is being obtained at the Leadville plant, and the concentrate contains about 20 percent zinc and some gold and silver. It is of interest to note that this mill has been working on material from the dump of the South Moyer Mine, which dates from 1874.

John Hamm Mining & Milling, Ltd., is another organization that has been successfully treating dumps that accumulated through the years when zinc was thrown out as worthless or, later on, because it was too lean to be treated by the methods then available. This concern has been operating since 1937, recovering gold by jigging and amalgamation and base metals by flotation. The California Gulch Mining & Milling Company also ran two mills on dump ores last year. Smelting ore was shipped by the American dump, Reynolds and Young lease, Ibex Mining Company, Rock and Dome mines, Stone dump, Dolly B., and Wolcott dump. Crude ore from the Fortune Mine, worked under lease by Paul R. Clark, was transported to the Golden Cycle Mill at Colorado Springs for flotation treatment. Gold production dropped because John Cortellini, Leadville's mayor for the past seventeen years, had to close down his mine under the government order concerning properties yielding primarily gold.

The Leadville Drainage Tunnel, as the project is known, is the outgrowth of agitation for such a structure that began in 1932. A proposal for a tunnel at a lower elevation than the present one was submitted to the Public Works Administration in 1933 and again in1935 and in 1938. It was to be driven from a portal at Elevation 9350 and extend northward into the mineralized area, with laterals to the four principal water basins, as required. Its length, exclusive of laterals, would have been more than 27,000 feet and its estimated cost in excess of $3,000,000. When the scheme was first proposed it was not eligible for Federal relief funds, as national relief legislation took no account of mining projects. Subsequently, efforts were exerted to make it conform to PWA requirements, but it still failed to gain approval.

With the nation's entrance into the war, the need for base metals became acute, and attention was again turned to the Leadville area. Data on the ore reserves that had been submitted with the earlier applications were reviewed, and the Bureau of Mines was requested by the War Production Board to make its own investigations. These inquiries confirmed the fact that large quantities of base metals could be made available by driving a tunnel, and the question then resolved itself into one of determining the most suitable bore to meet conditions. Although the deep tunnel originally suggested would have provided drainage for virtually all the known ore bodies in the four basins, it possessed the following disadvantages: high cost, long construction time, and technical difficulties incident to driving through 16,000 or 17,000 feet of unconsolidated glacial deposits

A shorter bore at a higher level was consequently favored. Some thought was given to using the Canterbury Tunnel—an exploratory bore—which was built by the Leadville Mine Development Company some years ago. Its portal is at Elevation 10,077 and is about half a mile from that of the tunnel now underway. It would have been necessary to enlarge and to lengthen the Canterbury Tunnel, which is 5x7 feet in section and 4000 feet long. In the end, it was decided to drive an entirely new bore at a level approximately 75 feet below the Canterbury grade.

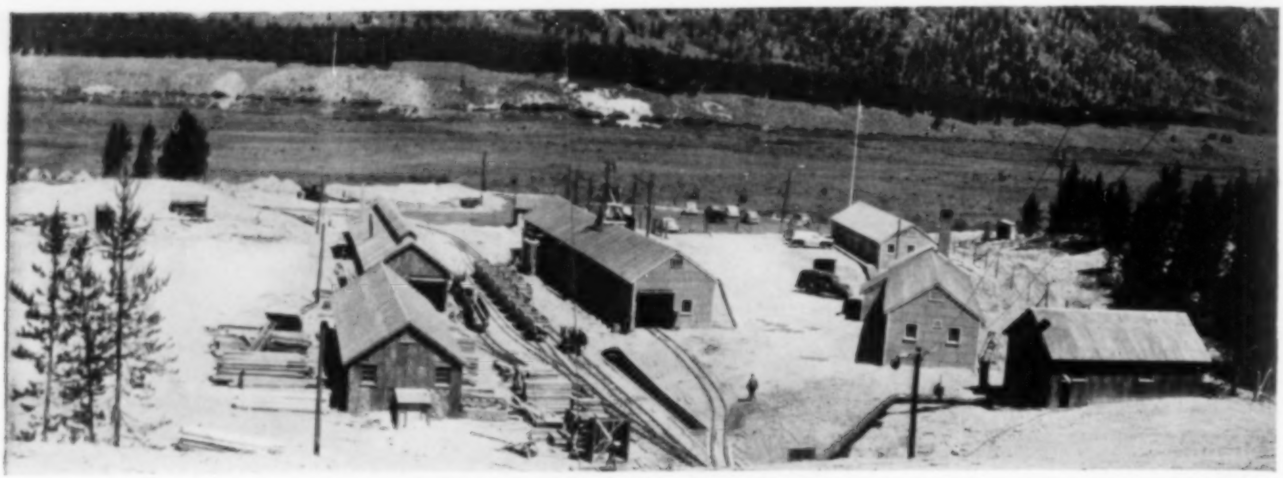
The Bureau of Mines estimated that the tunnel would unwater horizons containing two million tons of sulphide ores averaging 15 percent zinc, 3 percent lead, 3 ounces silver, and 0.02 ounce gold; one million tons of oxidized ores averaging 14 percent zinc; and perhaps an additional million tons of ore carrying 16 percent of manganese. Its investigations indicated that about ten billion gallons of water would be removed by the bore. The normal inflow is estimated at around 6000 gpm. This water apparently comes from melting snow at higher elevations on the Continental Divide and seeps from overlying glacial moraines into cracks and crevices in bedrock, eventually finding its way down to the mines of the Leadville District.

In 1943 the Bureau of Mines recommended to the War Production Board that the tunnel be driven, and the latter group approved it. The Interior Department Appropriation Bill passed by Congress last year included $1,400,000 to finance the undertaking, the funds

Bureau of Mines Photo

CORE-DRILLING RIG

The Bureau of Mines drilled ten vertical holes down to the tunnel line at different points to ascertain the character of the ground that would have to be penetrated. They were sunk to bedrock with a churn drill and completed to tunnel grade with the diamond-drill rig shown here.

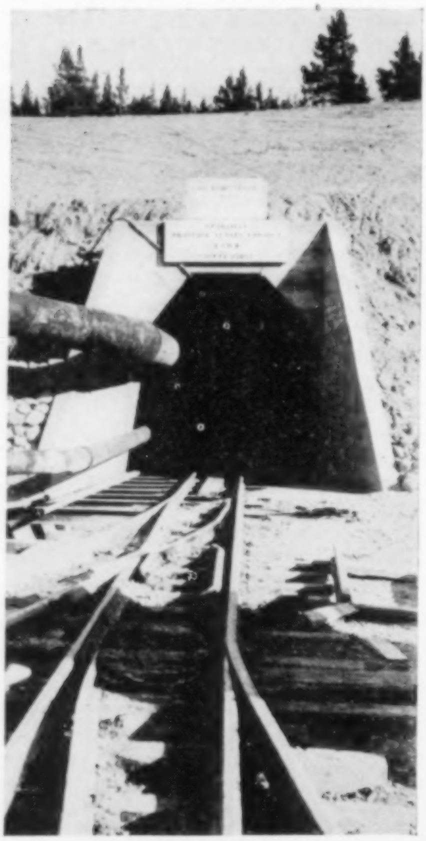


Bureau of Mines Photo

to remain available until expended. The amount is $100,000 less than was requested. The Interior Department ruled that an effort should be made to obtain repayment of the money through arrangements with the mine owners. A substantial number signed agreements before the funds were released, and as of June 1 owners of interests in approximately half of the claims in the area affected had done likewise. One man has been delegated the task of getting the signatures of the remaining owners, and because of their widespread geographical distribution it will be necessary for him to cover practically the entire country to do this. The agreements provide for royalty payments of 2 to 3 percent on ores mined below the present water level and above the tunnel level, and of 1 to 2 percent on those extracted from below the tunnel level.

The tunnel is being driven for the Bureau of Mines by Stiers Bros. Construction Company of St. Louis, Mo., on a cost-plus fixed-fee contract. Work at the site began last December 7, and tunneling operations were started on December 20. Exceptionally difficult conditions were encountered for the first few hundred feet, and these made progress very slow. The surface material consists of loose glacial deposits ranging from fine sand to large boulders and will not stand unsupported. Water was struck after the heading had been advanced 40 feet and caused the ground to run, necessitating the adoption of methods and equipment akin to those employed by subaqueous tunnelers. Four-by-six-inch timber spiles had to be driven around the full tunnel section except at the bottom, and breast boards were needed to hold the material back at the heading during excavating. Ten-by-ten-inch timber sets, consisting of side posts and a 3-piece framed arch, were placed every 5 feet and lagged all around to prevent inflow of the unstable ground.

At a point 350 feet from the portal, bedrock was encountered on the floor of the tunnel. This sloped gradually upward, so that for the next 200 feet the lower part of the bore was in rock and the upper in unconsolidated material. Even after the heading was entirely in rock, the latter was so fractured and contained so many mud seams and so much water that it proved difficult to drill and handle. By June, when the face was 800 feet from the portal and there was 15 feet of rock cover, it was still necessary to drive spiling at the top. Rock conditions improved during the early part of the summer and good progress was made for several weeks. But bad ground was again encountered in August and had to be bypassed. On September 23 the face was 1878 feet from the portal. However, geological data and test borings made by the Bureau of Mines indicate that generally good rock conditions will be met throughout the remainder of the distance. Ten test holes were bored from the surface along the line of the tunnel, being put down to bedrock with a churn drill and completed to tunnel grade with a diamond drill.



TUNNEL PORTAL
AND CONTRACTOR'S PLANT

Because of the urgent need for the ores that the bore will make available, it was stipulated that the latter should be advanced regardless of the water encountered so long as it was reasonably possible to continue work. The maximum flow has thus far been 350 gpm., but provisions have been made to handle as much as 10,000 gpm. in timber-lined ditches at either side of the track. The tunnel is drilled and shot to grade, and the track is built up on timber stringers to a height of 18 inches. This leaves ditches 27 inches wide by 18 inches deep on both sides of the centrally located track.

The tunnel is 9 feet wide by 10½ feet high— large enough to be used as a haulageway for ore in case that becomes desirable. It will enter the mineralized area through ground that has not been thoroughly prospected at depth, and it is possible that some new ore bodies will be cut. When the bore gets into the section where mining has been done, a pilot hole will be carried well in advance of the heading to avoid any chance of breaking into old workings that are not shown on available maps, which are none too good. The subsurface is highly faulted and there are intrusive dikes at various intervals that may be acting as dams and holding back the water. This was found to be the case in the Canterbury Tunnel where the flow rose to 14,000 gpm. after one dike was penetrated. It continued at that rate for about four months. The normal flow in that bore is now between 4000 and

5000 gpm., and a slightly smaller volume issues from the Yak Tunnel. In addition to extending through dike dams, sections of the bore will run through limestone formations that are known to contain cavities formed by percolating ground waters. These may possibly serve as reservoirs and precipitate heavy flows into the bore when tapped.

In the Fryer Hill section the tunnel will be below the ore horizon. In the Carbonate Hill section it will be below the ore on the eastern side of the Iron Fault and above it on the western side. In the Iron Hill and Downtown sections it will be above the ore, but the pumping head will be materially lower than when water had to be lifted to the surface. At mines where the bore will have its greatest cover the pumping head will be reduced from around 1000 to about 400 feet. At the Pyrenees Shaft on Carbonate Hill the tunnel will be approximately 670 feet below the surface; at the Tucson Shaft on Iron Hill, 1000 feet; and at the Penrose Shaft in the Downtown section, 250 feet.

The contractor's equipment is generally similar to that employed on several other recent Colorado tunneling jobs, including the Carlton drainage bore at Cripple Creek, the Treasury Tunnel at Ouray, and the Alva B. Adams bore through the Continental Divide that was holed through last June. Most of it is rented to the Bureau of Mines by the John R. Austin Construction Company. A structural-steel drill carriage is in use and this has five Ingersoll-Rand DA-35 power-feed drifters mounted on the front and one on the rear. The latter serves to drill the pinholes that are used for securing the overhead ventilating line.

Drilling is done with Ingersoll-Rand Jackbits. New bits are 1⅞ inches in diameter and are reduced ¹⁄₁₆ inch in gauge at each resharpening, being employed until they are 1½ inches in diameter. Jackrods of 3-, 5-, 7-, and 9-foot lengths are successively used for each hole. A heading crew consists of five drill runners, five chuck tenders, and three nippers for changing Jackbits. Muck is handled by Eimco-Finlay No. 21 Rocker Shovels operated by compressed air and dumping into 91-cubic-foot Card Iron Works Granby-type cars which are hauled to the portal by 8-ton storage-battery locomotives and thence to the dump by a Plymouth gasoline-engine locomotive.

The blacksmith shop is equipped with an Ingersoll-Rand hotmill and two Jackfurnaces for reconditioning Jackbits, and with a No. 27 oil furnace, a No. 54 sharpener, and a Size 500 cut-off wheel for treating Jackrods. This is the second shop to be erected; the first one was destroyed by fire on the morning of April 15 and all the equipment was damaged beyond use. While it was being replaced by a fireproof structure the Jackbits and Jackrods were trucked to and from Grand Lake, Colo., where they were reconditioned in the shop maintained by Stiers Bros. Construction Company at the western end of the Alva B. Adams Tunnel. Compressed air for the Leadville Tunnel is supplied by two Ingersoll-Rand Type XRE compressors, each with a piston displacement of 1545 cfm. and operated by a General Electric 250-hp. synchronous motor. The discharge pressure is 125 pounds.

This is believed to be the first tunnel ever driven under the direction of the Bureau of Mines. Operations are in charge of R. A. Elgin, supervising engineer and contracting officer, and M. E. Volin, resident engineer. John R. Austin is directing the contractor's forces, and Louis Stiles is tunnel superintendent.

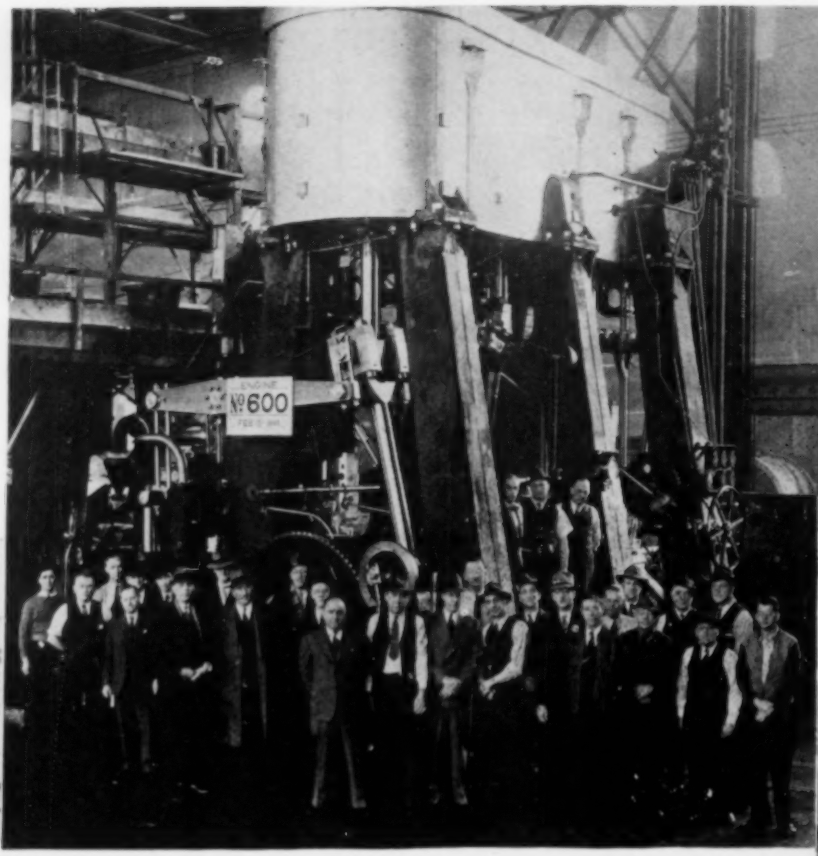
Photo by T. J. Barbre

ARKANSAS VALLEY SMELTER

Meyer Guggenheim went to Leadville from Philadelphia in the early days of the lode-mining era, when feverish excitement prevailed. Noticing that everyone was intent upon finding or digging ore and that no one was providing facilities for extracting the metal from it, he started a smelter at nearby Malta. The plant was the nucleus of the American Smelting & Refining Company. It is shown here as it looks today, with some of the highest peaks in the Rocky Mountains in the background. The smelter now treats ores from various Colorado mining districts.

MISCELLANEOUS VIEWS

The first engine produced by Hooven, Owens, Rentschler went into the Liberty Ship "Ocean Vanguard" which is shown below as it was being launched by the Todd-California Shipbuilding Corporation on August 16, 1941. The completion of the 600th engine February 15, 1944, was taken in its stride, work pausing only long enough to permit posing for the picture at the right. A general view of the crankshaft assembly floor (center) conveys an idea of the scope of the manufacturing facilities. The huge machine tool in the right-hand corner is planing both ends and two pads of an engine column at one time. Hours are saved by utilizing pneumatic impact wrenches for such operations as running nuts on the 1½-inch studs of the high-pressure cylinder, as shown at the bottom, center.



An Engine a Day for a Liberty Ship

C. H. Vivian

MORE than one-third of the steam engines for the propulsion of EC-2 Liberty cargo vessels built in our shipyards during the war have been turned out by one concern, the Hooven, Owens, Rentschler division of General Machinery Corporation in Hamilton, Ohio. It has already produced more than 750 of these power plants, and by next January will have completed its allotment of 826 units out of a total of 2500 authorized by the U. S. Maritime Commission. Construction of the other 1674 engines has been divided among fifteen different firms. By its performance, the Hamilton factory takes rank with numerous other American industrial plants that have demonstrated Uncle Sam's remarkable latent capacity for shifting from a peacetime economy to war production with incredible rapidity.

The engine is of the vertical triple-expansion type and develops 2500 ihp. when turning the crankshaft at 76 rpm. Each completed unit weighs approximately 135½ tons and contains 15,742 parts, including cotter pins, bolts, etc. Its three cylinders have respective diameters of 24½, 37, and 70 inches and a stroke of 48 inches. During the last war a similar engine, which developed 2800 hp., was installed aboard Allied cargo vessels. Some of them were built by Hooven, Owens, Rentschler, but, while a creditable record was made, the production speed recently attained was not even approached at that time. However, the management felt that it had accumulated enough experience during those days to enable it to introduce shop methods that would materially reduce the construction period. Accordingly, it promised the Maritime Commission that it would build eight engines a month. At the time this was considered an extremely high mark to shoot at, and few persons outside of the company thought that it could be reached. Actually, it was exceeded almost from the beginning.

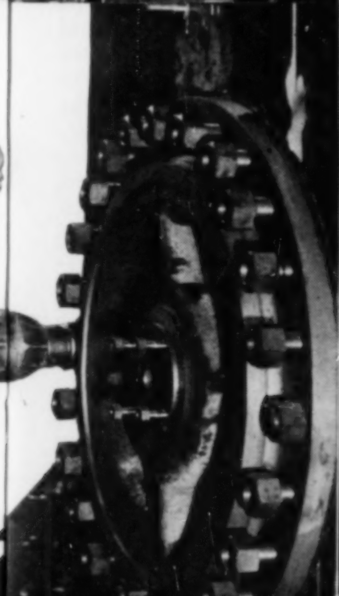
As know-how increased and planned machine-shop technique developed, the rate of production improved steadily. The peak was reached last November when 30 engines left the shop. This rate could perhaps have been sustained or possibly bettered had the Maritime

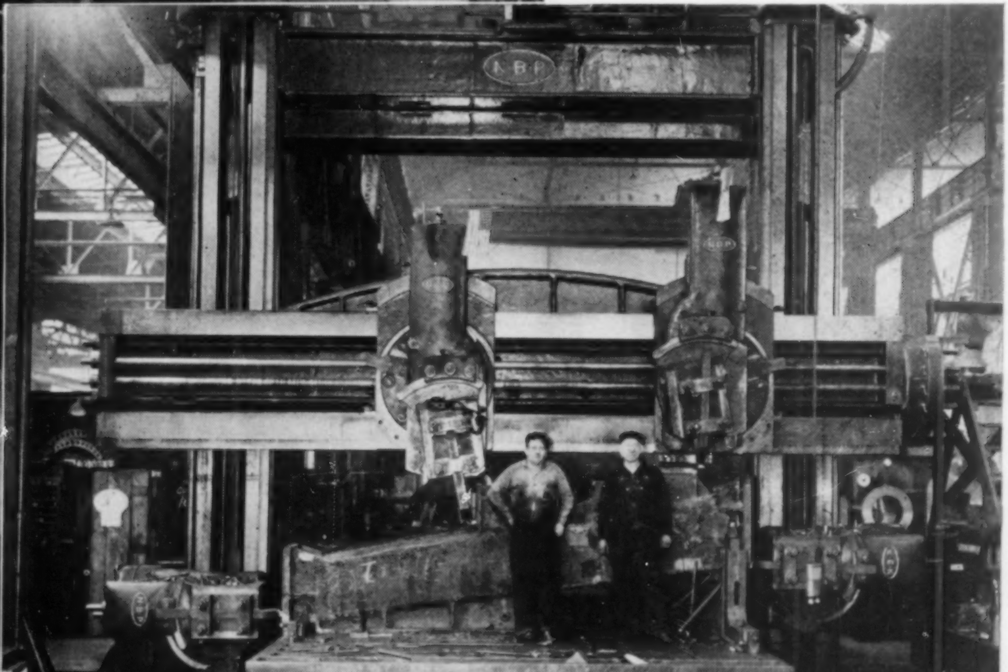
Commission's schedule of shipbuilding called for it, but around that time there began a slowing down of the Liberty Ship program, with many yards being converted for the construction of the faster Victory Ship. Consequently, fewer engines for Liberty ships were required, and Hooven, Owens, Rentschler dropped its monthly output to 25, then to 22, and is now turning out about twenty. But even this number is 150 percent greater than the goal originally set and considerably exceeds the best production rate attained by any other builder of these engines.

The Liberty Ship represented a compromise in design on the part of the Maritime Commission in order to build up a fleet of merchant craft for war service in the shortest possible time. In 1937 the commission adopted a program by which 50 fast cargo and passenger vessels were to be constructed each year for ten years with the avowed purpose of reviving America's moribund merchant marine. These C-type ships were to be of four sizes, most of them driven by high-speed turbines and a few by diesel engines. This program is still being carried out, but its pace has been accelerated since we entered the war. However, it takes much longer to construct a vessel of this kind than the easier-to-build Liberty Ship, so the latter was put into production as an emergency measure in the face of our dire need of a carrier fleet of adequate size for war purposes.

The Liberty Ship is a 10,500-ton, 442-foot conventional freighter with an average speed of 12 knots. It lacks the refinements and the speed of the C-type, but it lends itself to construction by mass-production methods, with hundreds of plants throughout the nation contributing parts for assembly in the fifteen yards that were designated to put them together. Even hull sections can be prefabricated and then joined on the shipways. This plan of building by factory streamline methods succeeded beyond the fondest expectations of its proponents. Contracts awarded before we entered the war allowed six months' construction time, and it took 244 days to build the first Liberty Ship. In early 1942 the allotted keel-laying-to-delivery contract time was reduced to 105 days, but many were skeptical that this schedule could be met. By January, 1943, however, the yards had far surpassed it, and the 79 ships delivered during that month represented an average construction period of 52.6 days. Still the time was whittled down; and ultimately the Kaiser yards at Richmond, Calif., put a Liberty in the water with steam up just seven days after the keel was laid!

The engine adopted for the Liberty Ship is of British design and was developed prior to our entry into the war. In addition to building ships powered by this engine in its own yards, the British let a contract for 60 to the Todd Shipyards Corporation in this country, the order being placed through their Amer-





ican agents Gibbs & Cox, marine architects. The latter awarded a contract for the 60 engines for those vessels to Hooven, Owens, Rentschler. Subsequently, when it became evident that our own cargo-ship building program would have to be speeded up in view of our probable involvement in the war, it was decided to install the British engine in our Liberty ships because it offered numerous advantages. Its dependability had been demonstrated in the last war; and other points in its favor were that it ran at slow speed, involved no lubrication problems, was easy to operate and maintain, there were many marine engineers who were familiar with it, and that extra engineers could be quickly trained. As the engine is driven with steam at 220 pounds pressure, the boilers required were easy to construct and could be obtained from numerous firms. Finally, and of paramount importance, was the fact that the engines could be built much easier and quicker than steam turbines and in many shops.

The original contract with Hooven, Owens, Rentschler was written on December 31, 1940, and the English drawings covering the engine were received on the same day. From these it was necessary to develop a complete new set of detail drawings based on American ideas of manufacture and tolerances, and to make patterns and flasks for the production of the needed castings, as well as jigs and fixtures for the machining operations. In the interest of saving time in the machine shop and of insuring a high degree of accuracy, a wider use was made of jigs and fixtures than ever before in the construction of marine engines.

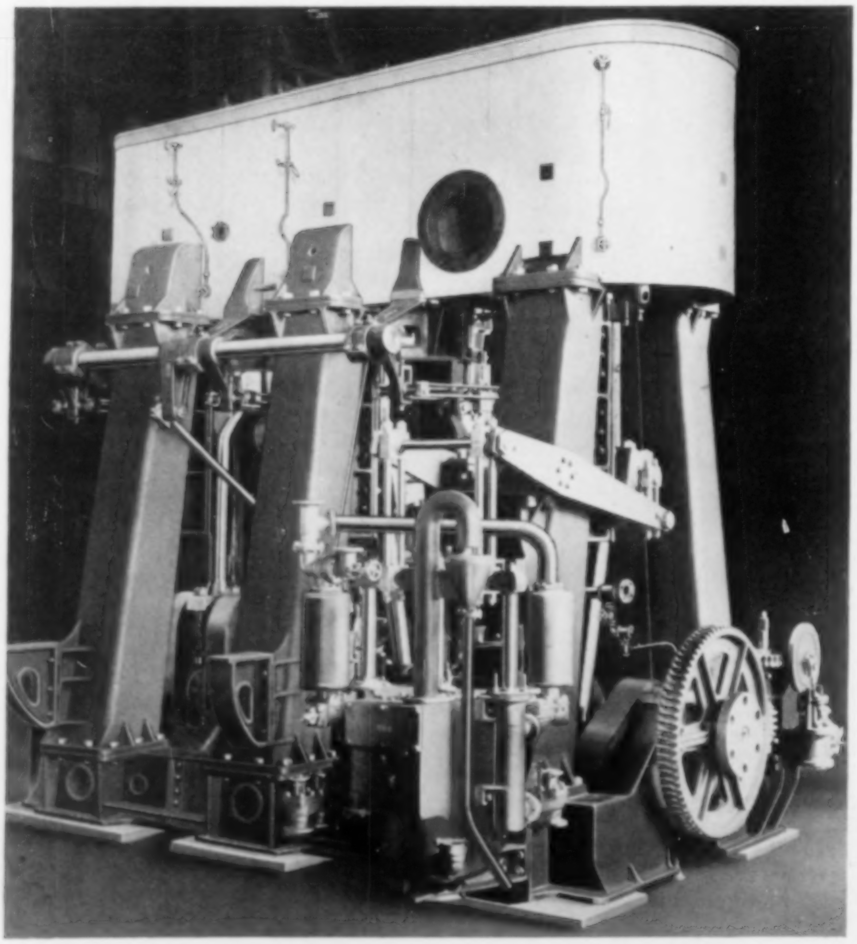
In addition to contracting to build engines, the company had agreed to act as design agent for the fifteen other American and four Canadian firms that also were to construct them. Accordingly, it turned over to them all its revised drawings, including those for jigs and fixtures. This insures complete standardization and makes it possible to obtain replacement parts from any one of the manufacturers. This is very important, as Liberty ships and their British counterparts are operating on the Seven Seas, and it is highly desirable that parts that are sure to fit be available in case of breakdowns no matter where the vessels may be. This has been taken care of by establishing supply depots in various sections of the world.

When Hooven, Owens, Rentschler took over the British drawings on the last day of 1940 its production staff estimated that it could be tooled up and ready to start shipping engines by the following August. On that basis, and with the knowledge that it would take some time to reach maximum production, the firm promised to deliver 22 engines during 1941. Actually, it began constructing engines earlier than had been expected, and shipped its first unit on July 1, 1941. During the remainder of the year it delivered 45 engines, or one more than double the number promised. In 1942 shipments totaled 209, or an average of more than seventeen monthly, and in 1943 they rose to 309, or an average of nearly 26 a month.

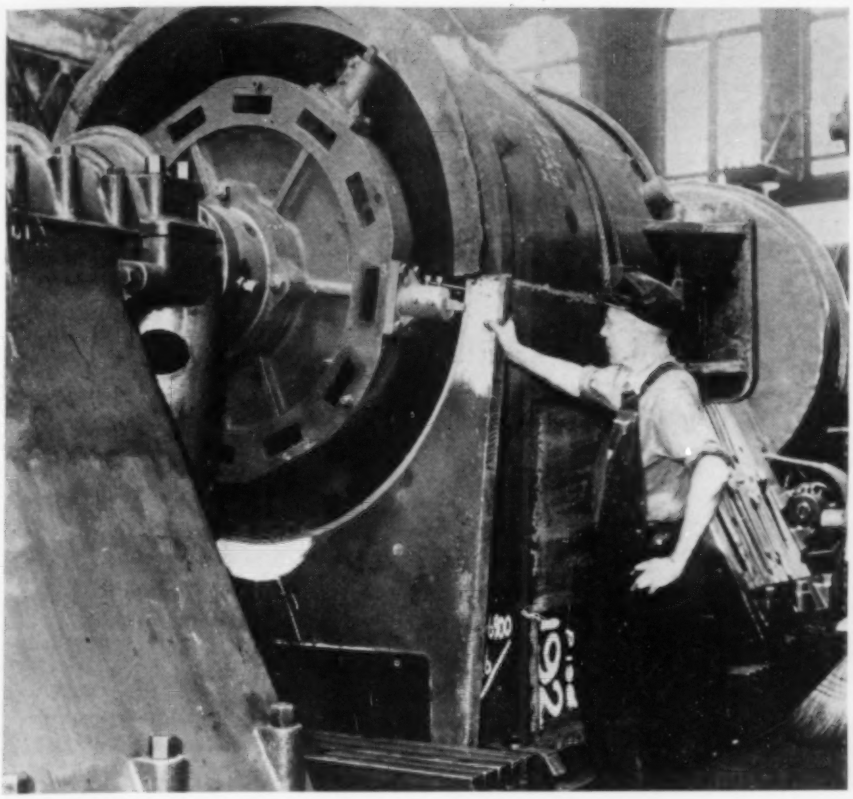
In taking stock of its resources when making preparations for production, the concern discovered that all the men who had been shop foremen 25 years ago when it was manufacturing similar types of engines were still in its employ and that some of them were serving in the same capacity. It also found that nearly 30 of its shopmen had worked on those earlier engines. Capitalizing on this situation, the management canvassed the men to determine what major difficulties had been experienced in building the World War I engines. It then designed and adapted machine tools to overcome those difficulties. More than $100,000 was expended for tooling; but it has resulted in the great accuracy which, together with some revolutionary foundry practices, is responsible for the speed of production that has been attained.

Evidence of the great part mechanical equipment has played in what has been accomplished is the fact that the working force never reached the number that might be expected. At the peak of operations there were 1039 employees, only eighteen of whom were clerks. Women run all the small milling machines. At one time there were more than 200 female workers; now there are around 150. In compiling the notable record, it has not been necessary to ask employees to put in inordinately long work weeks. The shop is organized on a 3-shift basis and, ordinarily, on a 6-day week. Even during the month when 30 engines were produced there was very little Sunday work.

In recognition of its contribution to the success of the vitally important Liberty Ship program, the Maritime

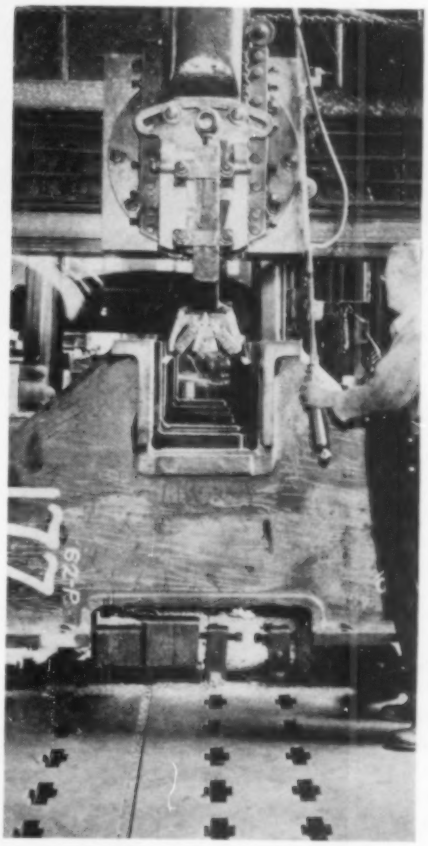


EXHAUST-SIDE VIEW OF A LIBERTY-SHIP ENGINE
The vertical, triple-expansion engine develops 2500 ihp. and weighs 271,000 pounds. Of British design, it was adapted for our Liberty ships because it was dependable, easy to operate and maintain, and could be built quickly. Convoys carrying vital war materials across the Atlantic have been composed largely of Liberty ships, and many naval men credit them with making it possible to win the war against Germany.



MACHINING OPERATIONS

These pictures illustrate two of the numerous machine-tool set-ups which, collectively, have contributed importantly to the fast rate of production attained at this plant. A horizontal boring mill (left) is used for cutting the shrinkhead from the 18,500-pound low-pressure cylinder by means of two cutters mounted on a spider-type toolhead. Six cutters are mounted on the head for the rough boring of the cylinder. The other view shows the 3-section, 36,500-pound bedplate and the two opposed main bearing jaws being planed at the same time. Both of these machine tools were made in Hamilton by the Niles Tool Works which, like Hooven, Owens, Rentschler, is a division of the General Machinery Corporation.



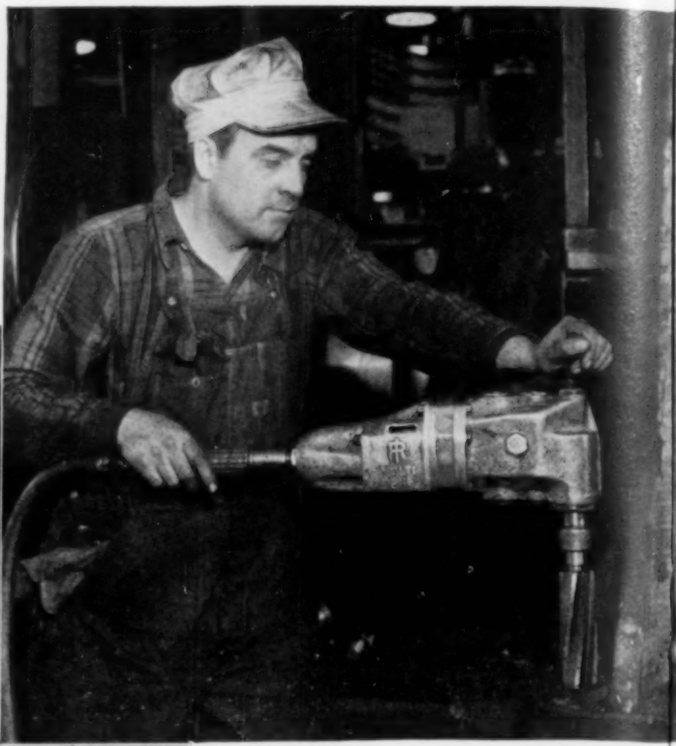
Commission awarded Hooven, Owens, Rentschler the first "M" to be granted to other than a shipbuilding establishment. The original award was made on July 9, 1942, and since then an additional star has been received at the end of each 6-month period. The firm was also given the Army-Navy "E," and was the first industrial concern to fly both symbols of excellence for the production of war material.

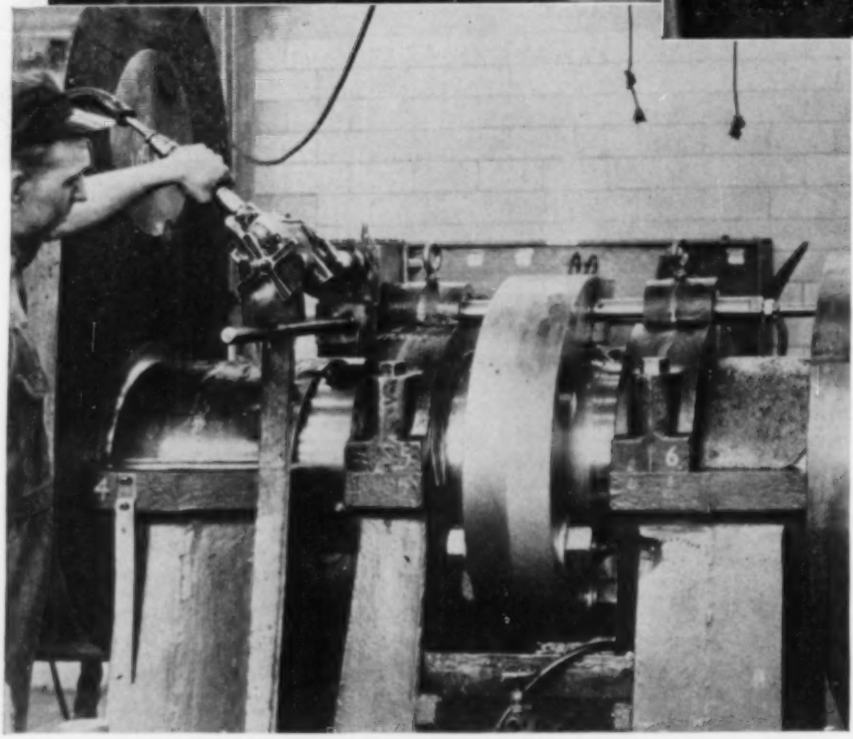
In planning for the job ahead, the firm arranged at the outset to obtain some of the component engine parts from other suppliers. All told, 46 subcontractors have worked in conjunction with it, and these have contributed as high as 115,000 man-hours of labor per month. This represents about one-half of the total hours of labor involved in producing the engines. Drawings of jigs and fixtures had to be furnished all suppliers in order that matching parts would be interchangeable, regardless of where they were made. These subcontractors are scattered throughout the eastern section of the country from Wilmington, Del., to Chattanooga, Tenn., and as far north as Menominee, Mich. When the 500th engine was turned out on October 6 of last year, representatives of all these firms gathered at Hamilton to witness its assembly.

Illustrative of the time-saving methods developed in the plant is the procedure by which the 32,600-pound crankshaft is assembled. It is built up of crankpins and shafts that are shrunk into forged crank webs and necessitates twelve shrink fits. Each crankshaft is 21 feet 3 inches long and composed of two sections, having respective lengths of 7 feet 2½ inches and 14½ feet. The longer forward section is connected to the high- and medium-pressure cylinders of the engine, and the shorter one to the low-pressure cylinder. The shrinking operation takes around six hours by the method conventionally used. But by designing special stands it has been reduced to as little as seventeen minutes, and the average time is a little more than that. Finish-turning operations are performed after the crankshaft has been assembled. The company was requested by the British Admiralty to prepare a description and photographs of the procedure and equipment involved so that it might pass the information along to engine builders overseas. Since May 10, 1943, the crankshafts have been assembled and machined in a separate building that was erected with funds provided by the Defense Plant Corporation. It was designed for an output of 25 shafts monthly, but has produced up to 30.

The bedplate of an engine weighs 36,500 pounds and consists of three cast-iron sections bolted together. The unit assembly is machined, as illustrated, with a single tool having two cutters which plane opposite sides of the main bearing jaws at one time. The width of the opening is held to 17 inches with minimum tolerance. A single cutting tool is used in planing the bottom pads and the top bearing-cap seats. The accuracy of alignment thus obtained insures a proper fit of the main bearings and is reflected in the comparative ease with which the crankshaft is brought into proper position upon them. There are six bearings, and when the crankshaft is lowered into place it generally contacts all of them fully at the first trial.

Pneumatic tools play an indispensable part in the shop routine, and a few of the numerous operations they perform effectually and quickly are shown in accompanying illustrations. Drills, grinders, and impact wrenches predominate and serve extensively both in the preparation of the parts and in their assembly. Impact wrenches have made it possible to save many hours in the aggregate on such work as setting studs and bolts and running up nuts. The latter are used in huge quantities, a single





AIR-OPERATED TOOLS

By using pneumatic tools, innumerable operations are done quicker and better than by any other available means. These pictures show Ingersoll-Rand tools of various kinds performing typical services. In assembling the two built-up sections of a crankshaft, holes in couplings are reamed and spot-faced with a tool driven by a Multi-Vane drill through right-angle, 30-to-1 gearing (above). The two corner views show different types of grinders in use. The other picture on this page illustrates how a Multi-Vane close-quarter drill reams bolt holes in a bed-plate-housing flange where there is little working room. A chipping hammer (next page) quickly cuts oil grooves in the babbitt of a main bearing.

shipment of the 1¼-inch size amounting to a boxcar full, or 109,000. On one stud-setting job, the average time when it was done with a ratchet wrench was thirteen minutes. This was reduced to eleven seconds by changing to an Ingersoll-Rand Size 534 impact wrench. This is a small tool that is handled by one man.

Castings for the engines are made in the foundry of the Niles Tool Works, an affiliate that is another division of the General Machinery Corporation. It is a thoroughly modern foundry, with one 66-inch and two 72-inch cupolas for melting iron. A feature of it is a Whiting cupola-charging system that enables three men to do the work that formerly required up to eighteen. Metal, limestone, and coke are loaded into scale cars outside the foundry and run through an electrified tunnel to the cupola area, where they are elevated and discharged into any one of the cupolas. Pig iron and steel scrap are loaded into the cars by electromagnet, while stone and coke are drawn from bins fitted with air-operated gates. The system regularly handles 150 tons of materials daily and has transported as much as 190 tons. Pneumatic sand rammers and pneumatic jolt machines are used on the pouring floor in preparing the molds; and pneumatic chipping hammers, grinders, and other tools are employed in the casting-cleaning department.

The three engine cylinders are set up on parallel blocks on the erection floor and assembled before being transferred to the top of the engine columns. The cylinder bores are accurately lined up, the top and bottom surfaces of the cylinders are carefully checked for alignment, and all necessary corrections are made before the assembly is placed on the engine. Each engine is completely built up and turned over by compressed air for testing. After passing inspection, it is partially dismantled—the bed, main bearings, and crankshaft being shipped as one unit and the cylinders as another.

Four railway flat cars are required to transport each engine. Shipments are made to all the yards that are constructing Liberty ships. These are located on the nation's three coasts, and the nearest one is more than 500 miles distant.

By tradition and experience, Hooven, Owens, Rentschler and its associate, the Niles Tool Works, are well grounded in the work they are doing, and their identification with engine building and with construction for war purposes is only natural in view of their histories. In 1945, Hooven, Owens, Rentschler will round out an even century of existence. The concern from which it originated was the Owens, Lane & Dyer Company, which was organized to build traction engines, sawmills and engines, and to do general machine work. In 1882 "Boss" George Adam Rentschler and Col. J. C. Hooven, together with four other partners, bought it and gave it its present name. Ever since then the name Rentschler has been closely associated with its management and that of related firms. The new owners started building Corliss-type steam engines, and later added machinery for sugar mills, plate-glass machinery, and mechanical presses. The business was conducted as a partnership until 1901, when it was incorporated.

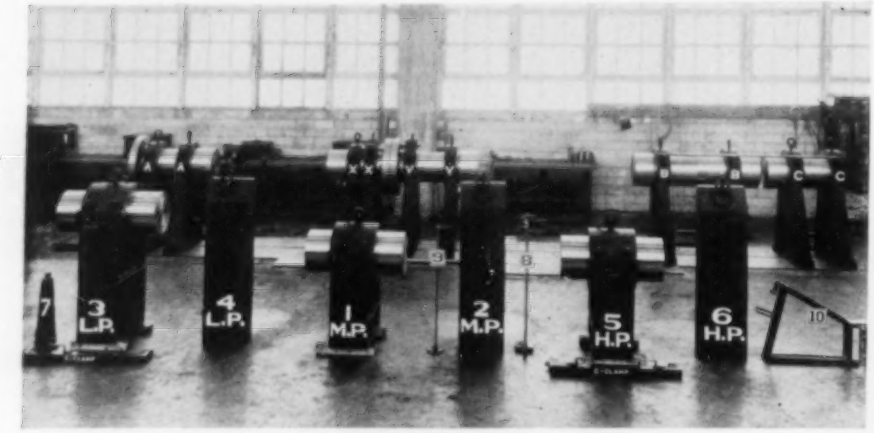
The Niles Works was founded in Cincinnati in 1845. The concern's principal business was the construction of steam engines for river boats, sugar and sawmills, locomotives, etc. That there was a considerable boom in the engine business around that time is shown by an old New Orleans newspaper clipping, which is now framed in the company's offices. It recounts that 355 engines had been installed in Louisiana alone, and that 281 of them came from foundries in the Cincinnati area. Of the latter, 70 were built by Niles.

In 1857 the locomotive business was acquired by I. & E. Greenwald. Thirteen years later the steam-engine business was sold to Mr. Steadman of Aurora, Ind., and the sugar-mill business to Blymer & Morton of Cincinnati. The machine-tool interests were transferred to Hamilton in 1871 under the name of Niles Tool Works. The move was invited by the donation of land, brick, and stone by the city, as well as a certain amount of waterpower from a canal run from the Big Miami River by the Hamilton-Rossville Hydraulic Company.

Later, the firm expanded its line to include machine tools for industrial and railroad shops, mechanical presses, and related equipment. Around the turn of the century, and for many years afterward, it supplied a large proportion of the shop tools used by the country's railroads in the manufacture and maintenance of locomotives and cars. In 1899 the company participated in a merger with Bement, Miles & Company of Philadelphia, Pa., the Pond Machine Tool Company of Plainfield, N. J., and the Philadelphia Engineering Works of Philadelphia, to form Niles-Bement-Pond Company. As a unit of that organization Niles was a leading builder during the last war of boring mills and similar machinery for the making of large-caliber guns. One boring mill was 50 feet between uprights and had a 36-foot table. In the present war it has continued to furnish the same type of machinery and has constructed some double-ended boring lathes that are 300 feet long. On a Russian order, Hooven, Owens, Rentschler shops have turned out a 552-ton mechanical press that is reputed to be the largest of its type ever made. It also developed the presses that made the automobile-body steel turret top possible.

Three of the six sons of the original Adam Rentschler have risen to eminent positions in life, two of them by way of their association with his Hamilton machinery interests. In 1901 Niles-Bement-Pond acquired ownership of Pratt & Whitney Company, of Hartford, Conn., manufacturers of precision machinery, small tools, and gauges. In 1925 the two concerns jointly organized Pratt & Whitney Aircraft Company, which was disposed of in 1929 to the United Aircraft & Transport Company. Frederick B. Rentschler, the fourth son, became interested in the aviation industry through these ramifications and is now chairman of the board of directors of the United Aircraft Company.

In 1928, Niles-Bement-Pond sold the Niles Tool Works to Hamilton interests and it was merged with Hooven, Owens, Rentschler to form the General Machinery Corporation. George A. Rentschler, youngest son of George Adam, is chairman of the board of directors and president of the parent concern. Another brother, Gordon S. Rentschler, elected to follow finance instead of machinery and is now chairman of the board of the National City Bank of New



EQUIPMENT FOR SHRINKING CRANKSHAFTS

The 32,600-pound crankshaft is more than 21 feet long and is assembled in two sections by shrinking crankpins and shafts into forged crank webs which are heated in oil for about 3½ hours to expand their bores. By means of special stands and methods, the time required for the twelve shrinking operations has been reduced from six hours to an average of eighteen minutes. The picture shows component parts of the stands. Those in the background are mounted on a base plate, being positioned by keys fitting in a keyway running longitudinally through the center.

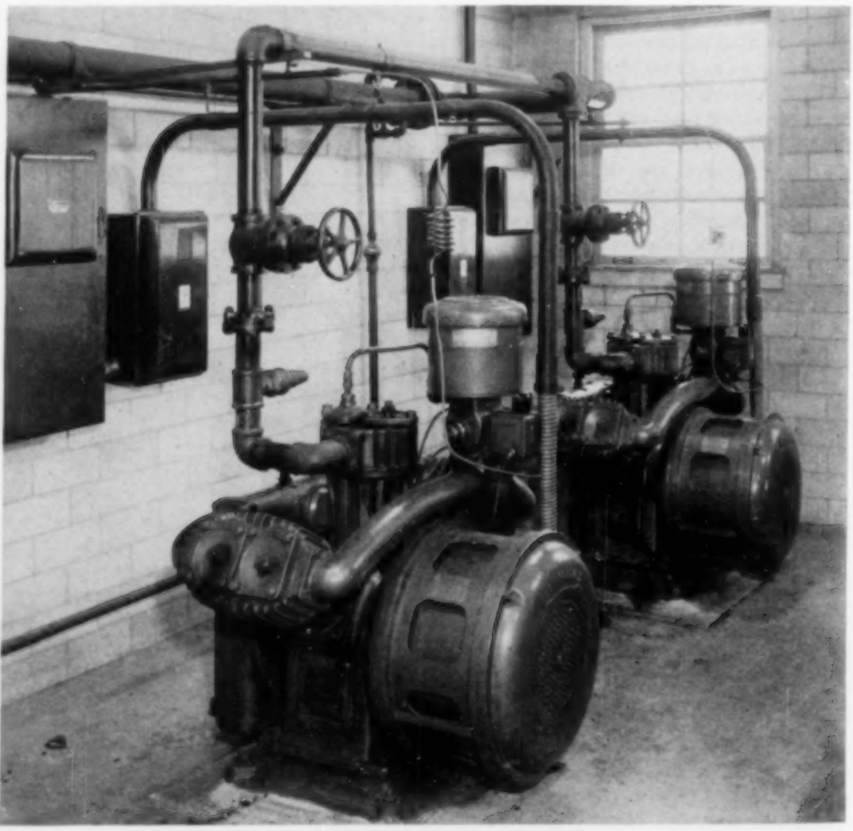
York, one of the largest banking institutions in the country.

In addition to building steam engines for Liberty ships, the General Machinery Corporation is also engaged in other war work, including the manufacture of diesel engines for different types of naval vessels and a larger engine of the same type for Maritime Commission ships. Because of its long experience in making machine tools for manufacturing ordnance, it was requested by the Government to operate a naval-gun factory at Charleston, W. Va. To carry out that assignment it organized the General Machinery Ordnance Corporation in October, 1940. The factory has finish machined more than 100,000 gun barrels ranging in size up to the 6-inch bore. It is also building other naval armament.

Hamilton, Ohio, where the two divisions of General Machinery Corporation are located, stands high in the list of American manufacturing communities in point of per capita production. A city of 55,000 inhabitants situated 25 miles north of Cincinnati, it has two factories which, in normal times, made three-fourths of the world's bank vaults and safes. The head offices and the largest mill of the Champion Paper & Fibre Company also are located there. Another prominent firm is the Hamilton Foundry & Machine Company, which is one of the principal subcontractors furnishing parts for Liberty Ship engines. It is headed by Peter Rentschler, a nephew of the chief executive of General Machinery Corporation.

There are many Hamilton families whose male members have been factory workers through several generations, and the tendency is for sons to enter the employ of shops where their fathers are. There is a theory that such a concentration of industry and the following of sons in their fathers' footsteps develop highly skilled workmen. The outstanding record that Hooven, Owens, Rentschler has made in building Liberty Ship engines seems to support this theory. The company management passes the credit for the accomplishment down the line and attributes its success especially to those directly concerned with the supervision of production. The key men who are responsible for keeping the work moving are:

Main shop: Thomas Gilmore, works manager; Lawrence Birdsong, production engineer; Don McKinnon, superintendent; Berry Mitchell, general foreman; Fred Claudipierre, foreman of large tools; Edward Weinman, foreman of small tools; Charles Duerstock, foreman of special small-tool and gauge room; Louis Pippert, foreman of tool and grinding room; Marcus W. Matre, foreman of lathe room; William Schoenberger, foreman of erection floor; James Mulcahy, chief inspector. Second shift: Charles Roth, superintendent; Frank Wilke, foreman; Walter Kinch, foreman of lathe room; Ray Chambers, foreman of small tools. Third shift: Earl Case, foreman of lathe room; Paul Weinman, foreman of small tools. Crankshaft shop: Cecil Hagen, superintendent; Joseph Wolpert, foreman; Louis Montague, night superintendent; George Schuler, inspector. General Machinery Corporation foundry, Fred Barendt, superintendent.



AIR COMPRESSORS

Since May, 1943, crankshafts have been assembled in a new building provided by the Defense Plant Corporation. This structure has its own source of compressed air—the two Ingersoll-Rand Motorcompressors shown here. Each of these air-cooled units has a piston displacement of approximately 400 cfm.

Drilling Frozen Iron Ore In Stock Piles

ON THE Marquette Iron Range in northern Michigan, soft hematite iron ores are stock-piled from trestles. Some are dry and some are wet, so layers of frozen ore are formed during the winter months. The ore is removed as needed by loading with power shovels, but the piles are higher than the working limits of the machines and the upper material does not cave readily. This results in dangerous overhangs that menace the workmen and must be brought down before loading can proceed. The Cleveland Cliffs Iron Company has evolved new drilling and blasting methods that accomplish this more satisfactorily than it could previously be done. These are described by Hugo H. Korpinen in the July-August issue of *Explosives Engineer*, from which the accompanying facts and illustrations were obtained.

The former practice was to load from a pile until overhang developed and then to bring it down by drilling and blasting from above. Holes 2 inches in diameter and 6 to 10 feet deep were put down with conventional rock drills, and 2-inch pipes were driven into them. Each hole was charged with from 8 to 12 cartridges of Gelamite No. 2, which has a bulk strength of about 45 percent. Aside from the hazards involved in doing the work concurrently with the shovel operations, delays in loading often resulted.

By the new procedure, which was worked out at the Lloyd Mine near Ishpeming, the stock piles are drilled and shot a week or so in advance of loading—before any overhang develops. The holes are driven in the top of the pile as formerly, but instead of drilling a hole and driving a pipe into it, the hole is made by forcing the pipe directly into the ore. This is done with an air-operated paving breaker having a special attachment to fit the chuck and the 2-inch pipe. The latter is closed and pointed at the bottom end. A 5-foot length is first driven and is then removed by turning and at the same time lifting it with pipe wrenches. A 12-foot section is next inserted in the hole and driven to a depth of 10 feet. This is also withdrawn in the manner already described. From 12 to 15 of these holes are driven along the top of the ore pile and are then loaded and shot together.

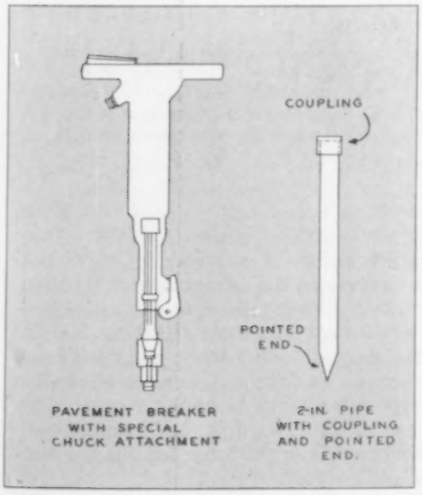
DRILLING CREW

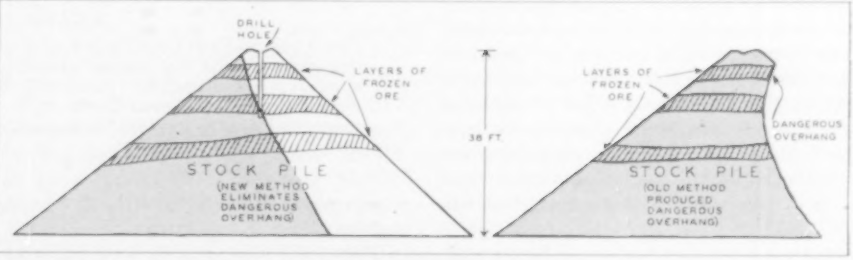
Two men using a CC-60 paving breaker with a special chuck attachment for driving a 2-inch pipe into a pile of ore. An experienced crew can drill and blast from 200 to 250 feet of hole a day.

An electric blasting-cap primer is placed in the bottom of each hole, and half a bag of Herculite No. 4 powder is then poured in and tamped. This powder has a bulk strength of about 15 percent. The remainder of the hole is filled with fine, dry ore. After all the holes have been charged, the leg wires of the primer caps are connected in series and attached to the lead wires, which extend to a blasting machine located at a safe distance.

It has been found that the shots produce vertical cracks that reach deep into the ore and break it up so that the upper layers readily cave when undermined by a power shovel. Experience has shown that if the blasting is done early in the spring, water and heat will penetrate the ore pile by way of the fissures and hasten the thawing of the entire mass. Time is saved because the blasting crews can proceed at will instead of having to wait until the power shovel has taken a cut from the lower part of the pile.

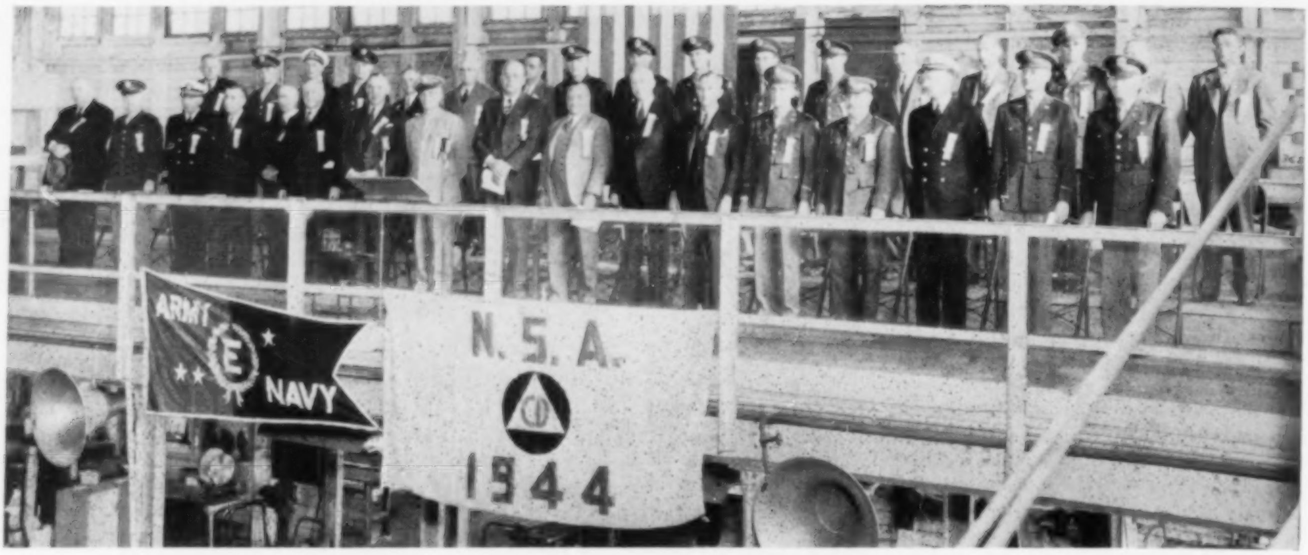
By shooting before starting loading operations, both sides of a pile are broken instead of only the side on which a shovel has been working, and by using the slower-acting and less powerful Herculite No. 4 bag powder instead of the Gelamite No. 2 cartridge powder a greater area is affected. The bag powder also has less throw and is safer, the quicker-acting Gelamite sometimes having scattered chunks of ore throughout a distance of several hundred yards. As the drilling and blasting crew now always works on top of a complete pile instead of adjacent to an overhanging section of it, that phase of the operations likewise is safer.


COUPLING
POINTED END
PAVEMENT BREAKER WITH SPECIAL CHUCK ATTACHMENT
2-IN. PIPE WITH COUPLING AND POINTED END.

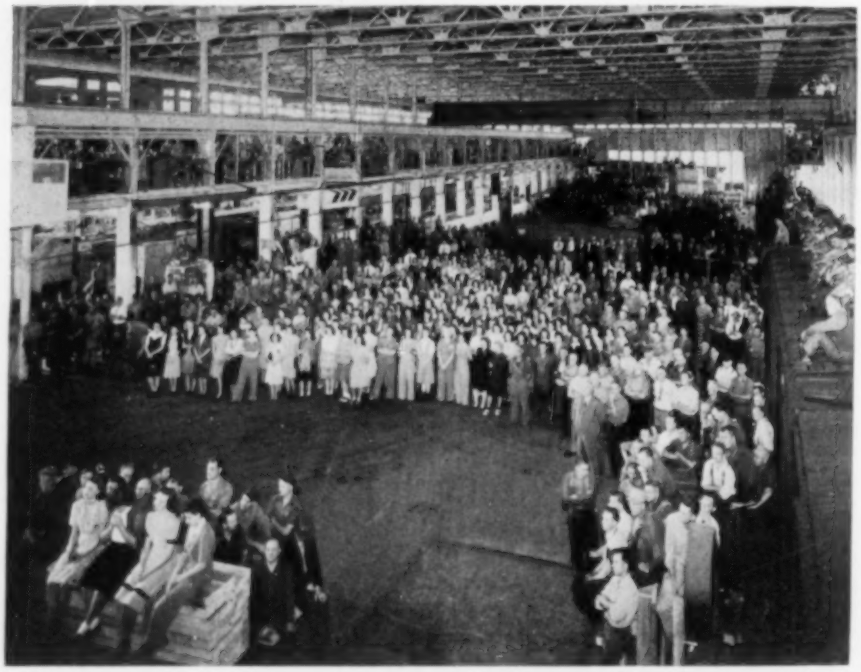


OLD AND NEW METHODS COMPARED

The left-hand sketch, above, shows the current method employed by the Cleveland Cliffs Iron Company for drilling and blasting partially frozen stock-piled ore to break it up before beginning loading operations. The right-hand sketch illustrates the condition that prevailed under the former procedure of drilling the pile after loading had been started. Details of the drilling tool are seen in the separate sketch at the left. The coupling on top of the pipe takes the force of the blows and protects the pipe end from that battering.



Compressor Plant Receives National Security Award



AWARD CEREMONIES

The Ingersoll-Rand presentation was made on the mezzanine of the plant shipping department, with employees assembled on the floor below. Standing at the speaker's station is Brig. Gen. E.G. Ziegler, who presented the lapel pins that accompanied the award. To the right of him is E.J. Smith, general manager of the plant, and next to the latter is Lieut. Col. Frederick Kraissl, Jr., who presented the award.

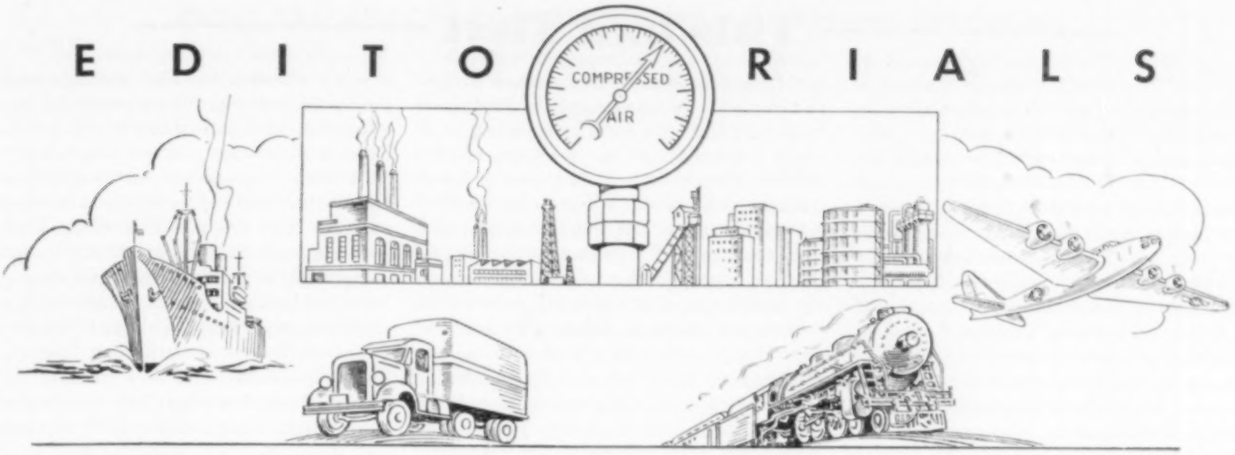
AT THE outset of the war, the Federal Government requested industrial plants engaged in war work to set up adequate measures to insure that production would not be interrupted or hampered by fire, sabotage, or similar untoward happenings, and outlined a standard procedure to be followed in organizing these facilities. The direction of this protective program was centered in the Office of Civilian Defense, which created state and local organizations to coöperate in the effort.

In order that those plants that excel in carrying out the recommended measures may receive public recognition of their endeavors, the National Safety Award was created. The award is an emblem of official approval of the preparations made against air attack, fire, sabotage, and avoidable accidents, as well as general excellence in observing regulations concerning blackout, dimout, and other local defense measures. To receive it, an industrial plant must be recommended for it by the local director of civilian protection, and the recommendation must be approved by the state director and by the chief of the plant protection section, Industrial Protection Division, Office of Civilian Defense, Washington. The award consists of a certificate and entitles members of the protection organization to wear lapel pins bearing the award insignia.

This National Security Award was presented on September 26 to two industrial concerns in one community, the Ingersoll-Rand plant at Painted Post, N. Y., and the Corning Glass Works in the adjoining city of Corning. The Ingersoll-Rand plant is generally acclaimed as the largest individual establishment in the country devoted almost exclusively to the manufacture of air and gas compressors. Portable air compressors turned out there are in service in every battle area.

The award was presented at the Painted Post factory by Lieut. Col. Frederick Kraissl, Jr., Chief, Plant Protection Section, Industrial Protection Division, Office of Civilian Defense, and was accepted by General Manager E. J. Smith. Lapel pins were presented by Brig. Gen. E. G. Ziegler, of Buffalo, N. Y., Deputy State Director, Office of Civilian Protection, Western District, and were accepted by a plant employee, Fred Stratton, acting on behalf of those privileged to wear them. Others participating in the program were the Rev. Carl J. Grabb, director of civilian protection in Painted Post; Mayor Karl L. Gaiss of Painted Post; Mayor Daniel Stimson of Corning, director of civilian protection in the Corning-Painted Post area; and Edward C. O. Thomas, civilian protection director for the State of New York.

EDITORIALS



A CINDERELLA METAL

ONLY a few years ago, magnesium was a comparatively rare metal, rather high-priced and more or less of a laboratory material used principally in flashlight powder, fireworks, and flares. Scientists spoke of its admirable qualifications for various services where light weight was a requisite and predicted that it would some day attain considerable industrial importance. But no one could forecast the phenomenal rise to prominence that has been its lot as one of the Cinderella metals of the war.

A 1921 edition of an American textbook on chemistry stated that "magnesium is of comparatively little commerical importance," and it continued to be regarded in that light during the ensuing years. The Germans, however, didn't share that viewpoint. When Nazi planes were shot down in England early in the conflict, some of them were surprisingly found to contain up to 1000 pounds of magnesium parts that had been fabricated from forgings, castings, extrusions, and rolled material.

As the United States neared involvement in the war, we had virtually no domestic sources of supply. We got what we urgently needed from abroad and, meanwhile, began feverishly to prepare to exploit our own resources. A revolutionary process for extracting magnesium from sea water was successfully applied on the Gulf Coast, and several establishments were set up for recovering the metal from its ores. Jointly, they gave us magnesium in continually increasing amounts until our war needs were fully met.

Now an anomaly arises, and the metal promises to become temporarily too abundant. On October 5 the War Production Board terminated its control of magnesium by removing the ban on its use for civilians. By the stroke of a pen its career as a critical metal was ended. The restriction was lifted as a result of the curtailment in military-aircraft production, and the decrease in the demand for magnesium that followed is but a foretaste of what may be expected when hostilities cease. It is predicted that the fabricated metal will then drop from 15 million pounds a month to 1½ million.

The Magnesium Association has already moved to take up the slack, and the indications are that the public will be the real benefactor of the wartime research and production program. The major problems of making and fabricating magnesium and its alloys have been solved, and a complete range of products will be available to meet the varying needs of peacetime trade.

Magnesium is two-thirds as heavy as aluminum and only one-fourth as heavy as steel. This relative lightness counts heavily when it is translated into the economics of the aviation industry, since every pound saved in constructing a transport plane will return around $400 through increased carrying capacity during the life of the craft. Along with light weight, some magnesium alloys have a tensile strength comparable to steel, and they can be machined three times faster. Although always found in combination with other elements, magnesium is very abundant in Nature, constituting 2 percent of the earth's crust and 0.13 percent of sea water.

Even before the war began, one manufacturer of printing presses had been able to increase the speed of his presses 25 percent by employing this lightest of all structural metals. With this example before them, magnesium producers are looking towards its use in numerous other mechanisms and appliances such as office and knitting machines, hand tools, radios, and cameras. They also visualize it as a competitor of some plastics. Favorable to magnesium are its ready machinability and current low price of around 20 cents a pound. Many engineers now in the aviation industry will, when they shift back to peacetime manufacturing plants, be "magnesium conscious" and lean towards it wherever it can be applied. The magnesium industry is already planning an intensive research program with facilities for passing on to those who can make use of it any information that may be gained.

CONTROL FOR GERMANY

THE presidents of five of the nation's engineering societies, with memberships aggregating 75,000, have jointly stated their opposition to the proposal by Secretary Morgenthau of the Treasury Department that postwar Germany be controlled by destroying or virtually dissolving her industrial plants. This course, they say, would penalize not only Germany but the whole world, would be economically unsound, and lead to another war. The fundamental fallacy of the suggestion, they contend, is that it fails to differentiate between the wartime and peacetime economy of the Reich. Agreeing that there should be no "soft peace," they assert that Germany should nevertheless have her chance to recover along peaceful lines. This cannot come about, they argue, through an economy wholly agricultural.

Instead of the Morgenthau plan, they recommend selective restriction and control of German industry. Specifically they would limit or prohibit the output of six materials that are essential to waging war. Factories making aircraft, synthetic gasoline, and aluminum would be eliminated, and importations would be held to peacetime needs. Facilities for extracting nitrogen from the atmosphere would be cut 75 percent, thereby controlling the production of explosives. The steel-making capacity would be reduced 50 percent. It is contended that war could not be waged or prepared for if any one of these steps were taken, and that all of them would afford ample insurance against war. The proponents of the plan sound the precautionary note that "It is unrealistic to assume that any program to take the sting out of Germany will not require supervision and vigilance for a long time in the future."

Signers of the statement are the presidents of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and American Institute of Chemical Engineers.

This and That

Portables Meet Air Emergency

When a motor driving a large air compressor in the Connersville, Ind., plant of the American Central Supply Company burned out on a Saturday, production of jeep bodies and other war accessories was crippled. Repairs were expected to take fifteen days or longer, so Army Air Corps headquarters in Indianapolis and the Office of Defense Transportation in Washington acted to get portable compressors on the job without delay. Over the week end, fifteen machines were located and shipped in, some from as far as Cleveland. By Monday morning they were hooked up and started on a 20-hour daily schedule. As the plant does not operate on Sundays there was little loss in production.

* * *

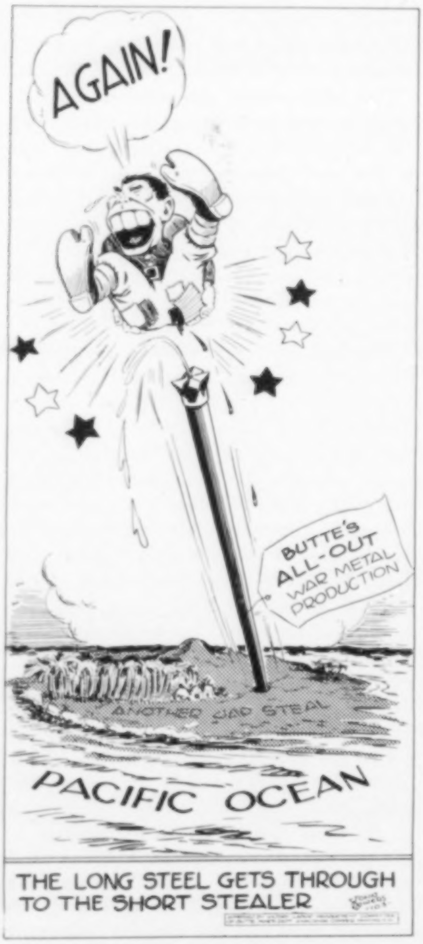
Rubber Relief Maps

Collapsible, rubber relief maps of enemy-held territory have been used effectively by Allied military forces starting with the Salerno invasion, it has been revealed by the United States Rubber Company. Before the opening of the Italian campaign, a hurry-up call was received for such maps. There were only two weeks available for their preparation, but they were completed on time by U.S. Navy personnel, transported to North Africa by plane, and then crossed the Mediterranean with Gen. Mark E. Clark's invasion army. These maps can be rolled up and will withstand shock, advantages not possessed by plaster ones. They are used to impart to landing forces accurate knowledge of the terrain they are to cover. Information on which they are based is gathered from all possible sources, including aerial photographs. A relief model is then made, showing all buildings and construction, as well as natural landmarks. From the master model is cast a plaster negative, with mountains registering as valleys. Onto the negative is sprayed rubber latex, which is reinforced to give it the necessary strength. When dry, the thin layer is stripped off, turned over, and colored to simulate the landscape.

* * *

Hecla Mine Closes

The Hecla Mine at Burke, Idaho, one of the famous old lead and silver properties of the West, has been worked out and closed down after producing more than nine million tons of ore having a gross value of $81,333,000. Ore reserves had been diminishing for many years and were finally exhausted after drifting and diamond drilling from the 3600-foot level had failed to reveal additional deposits. Legend has it that the Hecla claim was originally filed upon to obtain the land for a railroad right of way. Subsequent prospecting of the thickly forested tract disclosed a small quartz vein that ultimately yielded riches. In 1923, the mine surface plant and the town of Burke were destroyed by fire, but the mine was fully covered by insurance and resumed production with a new plant in 1924. The story of the Hecla was told in detail in our November, 1941, issue. Although the Hecla Mine itself has given up the ghost, the Hecla Mining Company is still very active, thanks to the management's policy of making investments in other ventures. It is half owner of the Sullivan Mining Company, which operates the Star Mine through the Hecla shaft, and the latter will accordingly remain in service. The Hecla Mill at Gem, Idaho, will continue to treat ore from the company's Silver Cable Mine, just over the line in Montana. In addition to these interests, the company is part owner of the Polaris Mine, adjoining the Sunshine, in Idaho, and is a member of a group of concerns that has acquired the old Resurrection silver-lead property and numerous adjoining claims in the Leadville, Colo., district. The completion of a drainage tunnel now underway there (described in this issue) is expected to revivify Leadville.


AGAIN!
BUTTE'S ALL-OUT WAR METAL PRODUCTION
ANOTHER JAP STEAL
PACIFIC OCEAN
THE LONG STEEL GETS THROUGH TO THE SHORT STEALER

UNSEATING THE JAP

Artist John Powers of Butte, Mont., chose a piece of drill steel to typify the weapons by which American miners are helping to oust the Japanese invaders from their insular bases in the Pacific. One of these inspirational cartoons is inserted in every pay envelope handed out to the employees of the Anaconda Copper Mining Company in Montana. They are sponsored by the Victory Labor-Management Committees of the metal mines department. Mr. Powers' position as a full-time artist with a mining company is probably unique. He is attached to the safety department, where he turns out posters and other educational drawings for display at the Anaconda properties.

* * *

War-Born Business Changes

With the return of peace, most industrial concerns that have diverged from their usual lines of work will go back to making their prewar products. In some instances, though, their war experiences will project them into completely new fields of endeavor. A case in point is mentioned in a recent news release of the Pittsburgh Plate Glass Company. The paint division of the company was obliged, during the war, to seek substitutes for Asiatic oils that were no longer available. By fractionating domestic oils, its technologists not only developed a satisfactory paint solvent but also produced an oil suitable for food products. More recently, additional refining has yielded an excellent plastic resin. As a result, a paint manufacturer will also make food oils and plastics in the postwar era.

* * *

Machines Versus Muscles

Commenting upon the fact that mechanisms are continually replacing manual methods of doing things, the *South African Mining and Engineering Journal* recalls that these departures from established routine have always been opposed in the beginning. The first engineer to use air-operated tools for breaking up street pavement encountered a storm of protest from his working gang. He is reported to have met this with the story of a foreman on an excavation job who assigned an Irishman to piling some lumber. After a few minutes, the laborer complained that he had no shovel. "But you don't need a shovel to pile wood," the foreman told him. "Maybe I don't," was the reply, "but why shouldn't I have something to lean on like thim other boys?"

Brass Annealing Furnace Designed for Continuous Operation

A FULL anneal of brass cartridge cases on a continuous-production heat-treating basis is now being accomplished in a Detroit plant with what is said to be the longest conveyor-type salt-bath furnace in operation in America. In addition, the cases come out of the heat treatment clean and bright and without the slightest trace of oxidation, eliminating the need of pickling or other cleaning. Two Upton electric salt-bath furnaces are in use, and each can anneal 6000 pounds of brass an hour. One gives them a full anneal at 980°F. before the nosing operation, while the second one full anneals them at the same temperature after nosing. It is claimed that each replaces ten noncontinuous furnaces.

The cases are lowered into the molten salt at one end of the furnace pot and moved through the bath at the rate of 60 feet a minute. After traversing the length of the pot, a turn-around area at the end permits the conveyor to carry them through again with a minimum drag-out of salt. Full advantage is taken of the width of the furnace by suspending three cartridges from each conveyor hanger. The operation is entirely automatic, with the exception of the occasional shovelful of salt that has to be added to replenish that lost in the process. The temperature of the bath is held within minus or plus 5°F. Should it vary more that that, a horn on the temperature control panel serves notice to that effect.

Uniform temperature of the entire bath is made possible largely through the placement of the electrodes. These enter the sides of the furnace instead of being thrust down into the salt solution from the top and conduct the current into the bath from transformers located outside the furnace. They are so positioned that the current transferred through the salt generates heat at the bottom of the pot, with the result that the normal flow of the heated solution is upward, thus assuring an even and uniform temperature. Electrodes of this type, which are not exposed to the combined action of salt and oxygen, seem to last almost indefinitely, for in their eighteen months of service no replacements have had to be made. An additional advantage of this electrode arrangement, in conjunction with the ceramic pot, is that it permits the use of ordinary commercial nitrate salts. Further, only 20 percent of the amount formerly required is needed.

The first of the furnaces to be installed has been in continuous operation for a year and a half and has been shut down only twice during that time for cleaning. This is an exceptional record when contrasted with the previous equipment which had to be shut down for thorough cleaning every week without fail. According to the management of the Detroit plant where the furnaces are in service, "they have paid for themselves in the first three weeks of operation."

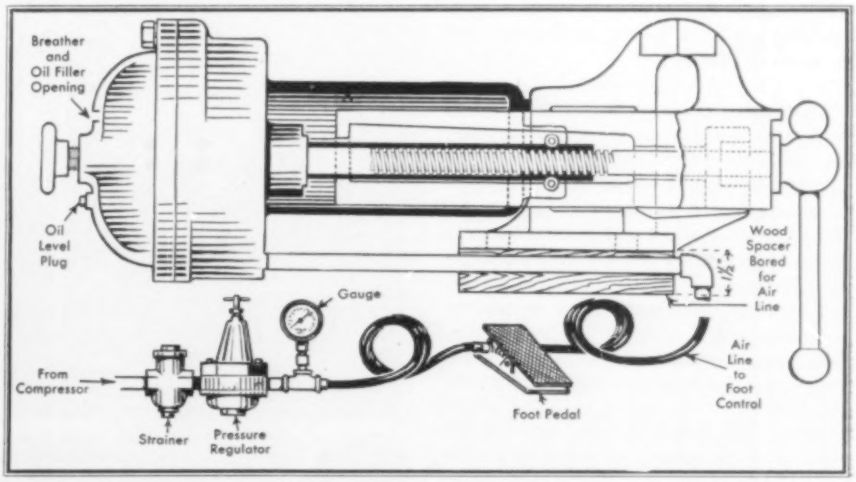
Vacuum Apparatus Tests Materials for Porosity

A COMPACT, portable apparatus that makes it possible to determine the relative porosity of materials has recently been assigned to The B.F. Goodrich Company. The unit consists of a vacuum chamber that is placed in contact with the substance to be tested, of a constant-speed power-driven fan that is started and stopped by a manually operated switch, of an air outlet, and of a pressure gauge and scale to measure and indicate the degree of partial vacuum in the chamber.

By drawing air through a test specimen, vacuum is induced in the chamber, and this determines the material's porosity. If it is highly porous the vacuum will be slight, but as porosity decreases the degree of vacuum increases. To facilitate reading the scale, the latter is mounted on a piece of translucent plastic and is reproduced on a transparent photographic film with a lamp placed behind it. The scale may be graduated in absolute units, or it may be made to show the relative porosity of two or more substances. The apparatus can be used for demonstration purposes. It was originally designed for testing sponge rubber.

Attachment Converts Hand into Pneumatic Vise

BY a compact attachment known as Vispeed, any standard 4- or 4½-inch vise can, it is claimed, be changed from hand to air operation. The new unit is essentially a pneumatic cylinder that is fastened to the body of the vise, while the piston rod is connected to the screw. Air up to 100 pounds pressure is used and applied by a foot valve, toe pressure on the pedal closing the jaws and heel pressure opening them. In either position the tool is locked. This arrangement leaves the operator's hands free to handle the work. With the 6-inch jaw opening set as required, the piston stroke can be adjusted within a range of 1 inch to vary the operating speed, and any holding pressure from zero to 2½ tons can be provided by regulating the air pressure. The unit was developed by The Bellows Company and does not interfere with the hand operation of the vise.



FROM HAND TO AIR CONTROL

The photograph shows a standard vise converted into a machine tool. The white circles indicate (top) the strainer, pressure regulator, and gauge interposed in the air line and (bottom) the foot control. The drawing shows the structural details of the Vispeed and how it is attached.

Industrial Notes

A new line of air-hydraulic gap-type speed presses has been announced by the Studebaker Machine Company. There are three models designed for maximum pressures of ¾, 1¾, and 2½ tons and for a wide range of work such as stamping, forming, punching, cutting, and riveting. The air-cylinder and hydraulic pump units are built into the body of the machine and are removable. The ram is operated by down pressure of the hand or foot and can be set to deliver a fast blow or a squeezing action to meet the requirements of tough or fragile materials. Release of the control causes the ram to retract automatically. The accompanying picture shows the Corsair that exerts a maximum pressure of 1¾ tons.

Studebaker
MACHINE CO.
MAYWOOD ILL.

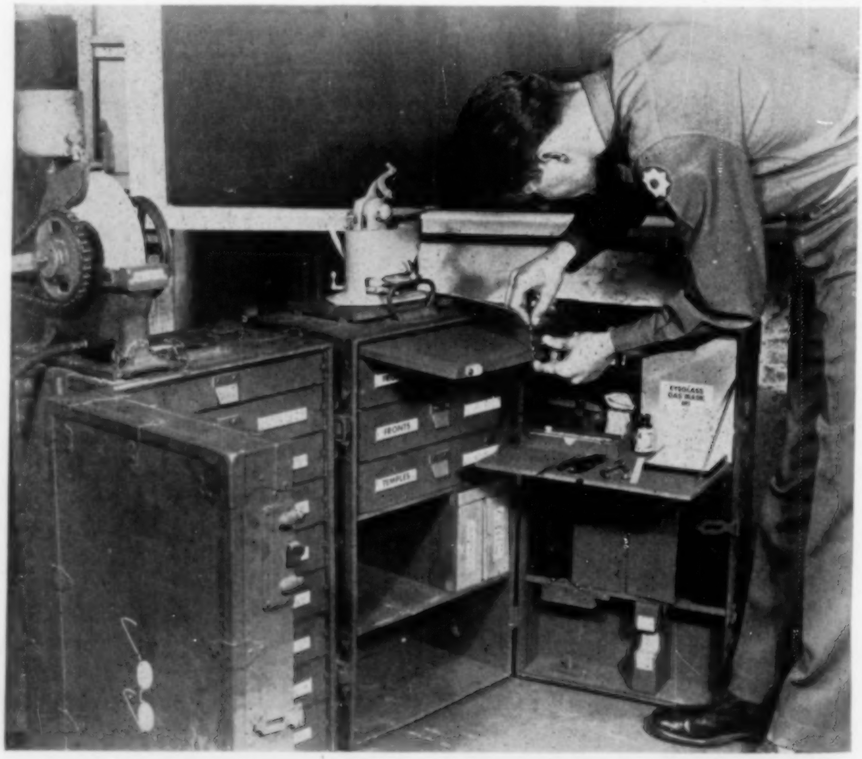
A fabricator of steel plates for armored vehicles has found that distortion resulting from flame-cutting can be reduced to a mimimum by doing the work underwater. Best results by this simple expedient are apparently obtained when the plate is covered with water to a depth of ¼ inch. It is reported that straightening operations are thus eliminated and that closer tolerances can be maintained.

To acquaint users of grinding wheels with the newly announced standard markings for the identification of such wheels and other bonded abrasives, The Carborundum Company has prepared a 136-page reference book called *Grinding Facts*. It contains among other data, a full explanation of the symbols; a comprehensive schedule of grading recommendations for general, toolroom, diamond-wheel, and thread grinding; a description of each common type of grinding; safety rules; and a table of useful speeds. To obtain a free copy of the book it is necessary to write the company, Niagara Falls, N.Y., on a business or company letterhead.

Tegul-Vitrobond is the name of a sealing compound for tanks, vats, floors, sewers, pipe lines, etc. It is compounded of sulphur and Thiokol—a synthetic rubber—and is said to withstand a temperature of 200°F., to resist hot or cold acid or mild alkaline solutions, to be impervious to liquids, and to have a bonding strength with brick of 400-500 pounds per square inch. It is made in a series of mixtures by the Atlas Mineral Products Company.

We are informed that silver may be deposited electrolytically on aluminum or aluminum alloys by what is known as the Preplate Process, a development of the Technical Processes Division of the Colonial Alloys Company. The work is done in the usual manner with the regular equipment and requires that the metal be thoroughly cleaned, passivated, and immersed in the special solution for a few seconds before electroplating. Considerable thicknesses of silver can be deposited directly on the aluminum surfaces, or follow copper, nickel, zinc, or cadmium plating. Adherence is said to be good; and torsion, heat, corrosion-resistance and weathering tests have shown up well. As silver on aluminum is rated high on the scale in heat conductivity, it may be considered favorably for many heat-transfer applications and opens up vast possibilities in the electrical-equipment, appliance, transportation, and communications fields.

For equipment such as grinding machines, the Whiting Corporation has developed a dust collector that varies from the systems usually used in that suction is induced by compressed air instead of a fan. The Hydro-Clone, as it is named, is mounted back of the machine and consists of a housing with twin inlets in the rear. These connect with exhaust outlets in the hood of the grinder and have connections for compressed air taken from a shop line and for water which is drawn from the bottom of the collector itself where it is maintained at a level a little below the inlets by a float valve. The introduction of air at 20 pounds pressure sets up suction that draws the dust-laden air and water into the housing, forming a sludge that settles on the bottom. Removal is effected at intervals through a hopper at the front of the collector, while the air passes through a Venturi above the water line and escapes by way of moisture separators near the top.



FRONT-LINE OPTICAL SERVICE

Mobile optical units now serving our armed forces overseas are being supplemented by this 1-man shop that is designed to fill average eyesight prescriptions and to make up a pair of spectacles in from 14 to 16 minutes. This is possible because the lenses in stock are already ground. The units are transported by plane or jeep, or carried if need be close to the front lines, and have been designed and built by the American Optical Company in accordance with Army Medical Department specifications.

Government Material for Sale

Raw and fabricated materials, standard parts, motors, hardware, fabrics, precision tools, equipment, and other surplus stocks are offered for sale by the Army Air Forces. Companies which are interested and want their names placed on the active bidders' list are requested to write to the Army Air Forces, Air Technical Service Command, Midwestern Procurement District, Municipal Airport, P.O. Box 117, Wichita, Kans., attention Property Disposal Section.

Members of the Northern Regional Research Laboratory of the U. S. Department of Agriculture have developed a substitute for cork that is said to resemble the natural product closely in appearance and texture.

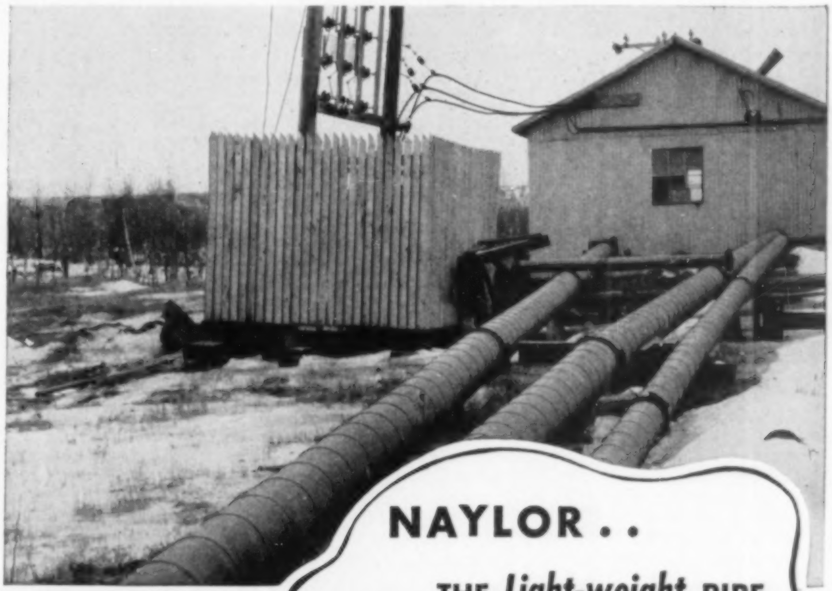
A fluid compound has been put on the market by the Merix Photo Company that is said to prevent any kind of glass or plastic from becoming beclouded through mist, fog, or steam. It can be readily applied with a soft cloth or cotton batting and also serves to remove dust, dirt, and fingerprints without marring even the softest plastic. The antifog preparation is not affected by exposure to light, is noninflammable, nontoxic, and nonacid.

Collapsible tanks are used extensively in combat areas by the Allies for the transportation and storage of gasoline and oil. They are made of a mildew-proofed fabric coated with synthetic rubber and must withstand temperatures ranging from zero to 165°F., as they are serving in both the South Pacific and European theaters of war. Being light in weight, they can be quickly set up or knocked down by a small crew for transfer to a new location, and can be repaired as easily as the inner tube of a tire. The tanks used for storage purposes hold 1,000 or 3,000 gallons, while the truck- or railroad-hauled containers have capacities of 750 and 2700 gallons, respectively. Three of the latter can be loaded on one flat car.

Neolite is the trade name of a new sole material for shoes that has been developed in the research laboratory of The Goodyear Tire & Rubber Company and is now in production. It is said to be neither rubber, leather, plastic, nor fiber and to provide a degree of comfort never approached before by any other material. According to the manufacturer, Neolite is comparable to leather in weight; but exhaustive walking and other tests have proved it to have superior wearing qualities. It is waterproof throughout its life, insulates the wearer's feet against heat or cold, and is less likely to slip on wet or dry surfaces than leather or rubber. It is available in brown and black, and may be applied to shoes by any of the conventional methods used in working with leather.

Pistons for aircraft landing struts and for other purposes where strength, lightness, and wearing quality are desired are made by flame-spraying bronze on steel. By the Neo-Mold process, as it is known, a special bronze alloy is sprayed on the bearing surfaces of comparatively light steel blanks to a thickness of approximately 0.045 inch. In the case of a strut piston, this involves the use of 3½ pounds of bronze, as against 7 pounds for the casting formerly required. It is said that the sprayed bronze absorbs and retains oil—becomes self-lubricating after short use—because of its fine porosity. The process is applied by the Neo-Mold Company, which also does the rough machining.

For the protection of surfaces exposed to severe corrosive conditions caused by gases, fumes, acids, alkalies, condensation, and abnormal weather, the Chemical Enamels Company is offering a coal-tar derivative named Butex. It is claimed to be suitable for metal, wood, concrete, brick, masonry, or cement, and is especially recommended for coating machinery, pickling and acid tanks, condensing coils, steel stacks, bridges, cranes, hoists, etc. It resists heat up to 500°F. Application is by brush or air spray.



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Naylor Pipe is outstanding for high and low pressure air and water lines. Sizes from 4″ to 30″ in diameter with all types of fittings and connections.

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COMPANY
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Inside information on POWELL VALVES

From the outside, this small size 200-pound "White Star" bronze Globe Valve looks very much like the same type of valve in other makes. But inside, where it really counts, Powell design and engineering show the results of nearly a century of "know how" in Valve making.

Among its many features are the regrindable and renewable semi-cone plug type seat and disc, especially designed for severe service conditions. The disc is made of "Powellium," a special nickel-bronze alloy developed by Powell Engineering. The seat ring is furnished in a specially heat treated Stainless Steel. Both are highly resistant to corrosion and erosion.

Of interest, particularly to maintenance men, is the fact that this valve can be *repacked under pressure* when wide open. This feature is provided by the machined face on the base of the bonnet which, engaging with the cut-off collar machined on the top of the disc lock nut, positively seals off the pressure from entering the bonnet. An exceptionally wide and deep stuffing box affords generous packing space. The protruding gland, held in place by a large stuffing box nut, also affords an additional guide for the stem.

The ground joint union body-bonnet connection, held fast by a heavy hexagonal ring nut, permits the bonnet to be easily and quickly removed from and re-attached to the body any number of times without impairing the tightness of the connection.

Ample space between the end of the pipe thread and the diaphragm prevents the pipe striking the diaphragm and distorting the seat when screwing the pipe into the body.

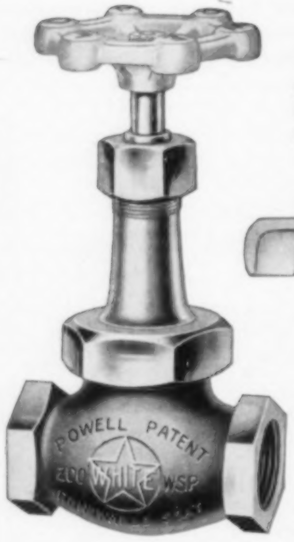
The malleable iron *non-heating* handwheel is designed to fit the hand and afford ease in operating the valve.

The complete POWELL Line includes Globe, Angle, Gate, Check, Relief, Y, Non-Return and other types of valves in bronze, iron, steel, pure metals and special alloys to meet the demands of all branches of industry for dependable flow control equipment.

The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati 22, Ohio


POWELL PATENT
200 WHITE WSP

This valve, especially adapted for handling water for cooling compressors, is giving long-life, dependable service in the compressed air field.

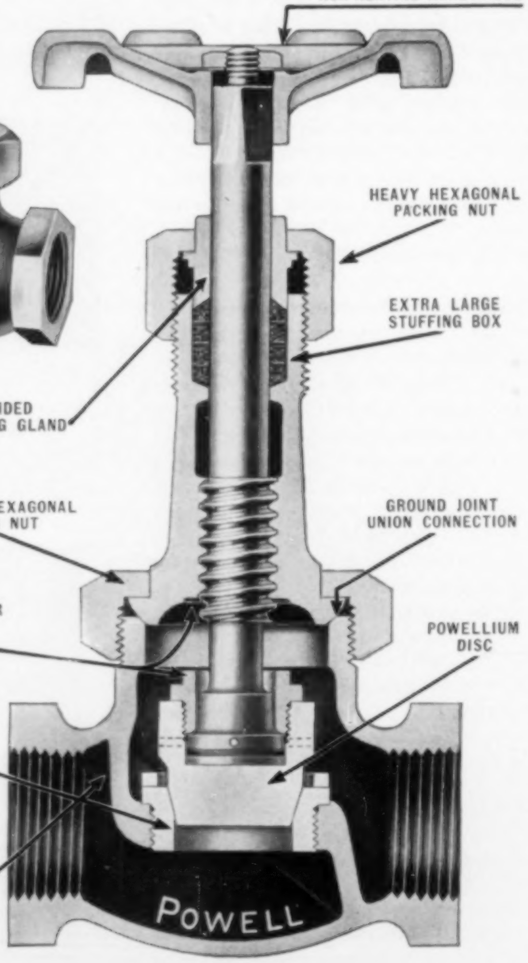
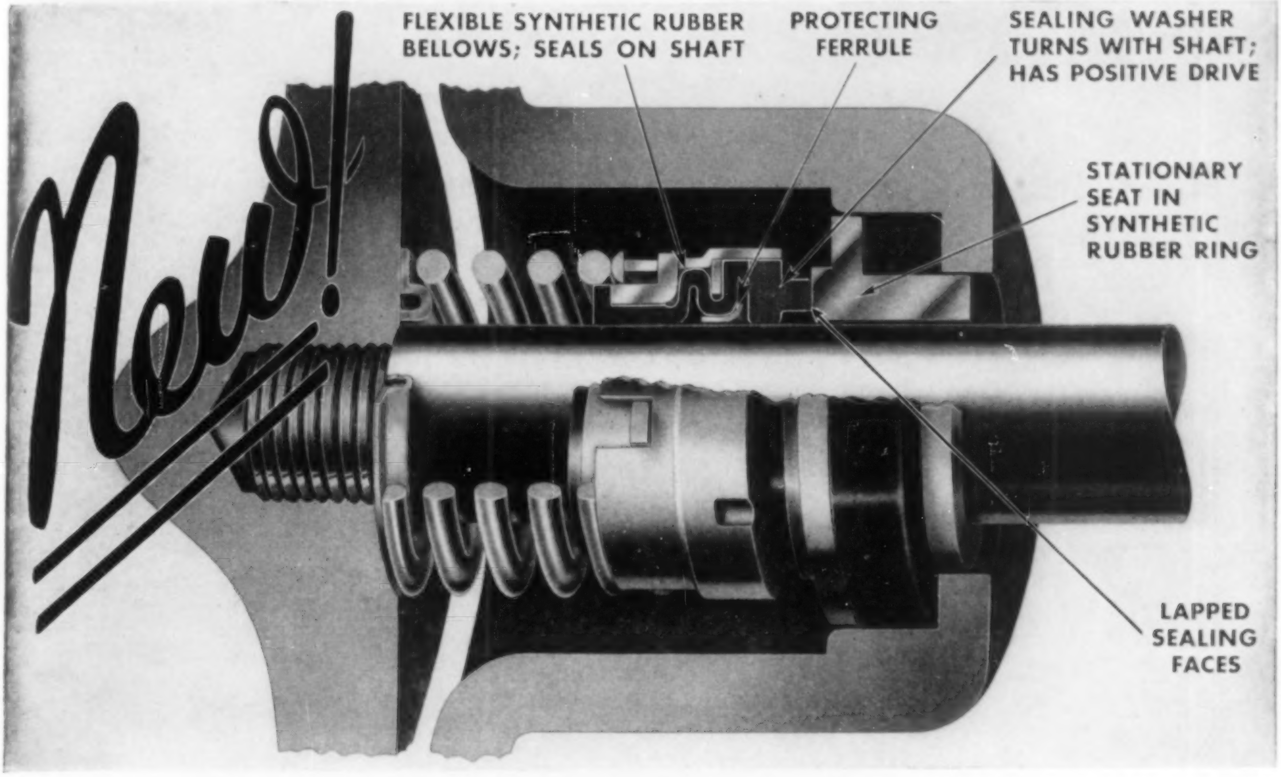

NON-HEATING HANDWHEEL
HEAVY HEXAGONAL PACKING NUT
EXTRA LARGE STUFFING BOX
GUIDED PACKING GLAND
HEAVY HEXAGONAL RING NUT
GROUND JOINT UNION CONNECTION
REPACK UNDER PRESSURE SHOULDER AND SEAT
POWELLIUM DISC
STAINLESS STEEL SEAT RING
AMPLE SPACE BETWEEN END OF PIPE AND DIAPHRAGM
POWELL

Fig. 1708
BRONZE "WHITE STAR" GLOBE VALVE

POWELL VALVES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FLEXIBLE SYNTHETIC RUBBER BELLOWS; SEALS ON SHAFT
PROTECTING FERRULE
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STATIONARY SEAT IN SYNTHETIC RUBBER RING
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Bellows -Type SHAFT SEAL

- **The Perfect Mechanical Seal** for Centrifugal Pumps—Refrigeration Compressors—Speed Reducers—Rotary Pumps—Agitator Shafts—Many Other Rotary Sealing Applications.
- **Eliminates** Leakage, Gland Adjustment and Shaft Wear—Reduces Friction—Saves Power—Seals Perfectly at High Speeds and High Pressures.
- **Exclusive Features** —
  1. **Flexible Synthetic Rubber Bellows Head** slides freely—provides automatic compensation for washer wear, shaft vibration and end play through wide range.
  2. **Protecting Ferrule** prevents Bellows Head from touching shaft. **Assures free sliding** at all times.
  3. Sealing washer has **positive drive** through metal parts.
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- This Precision-Built Shaft Seal is already thoroughly proven on many exacting services.

Design and Development Engineers — Send for Illustrated Bulletin

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Bellows-Type
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Protect your production... with AO Safety Goggles

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FLEX-DISC CLUTCHES

Used on the entire line of I-R *Mobil-Air* Compressors, have a time proven drive disc with flexible fingers solidly bolted to the fly wheel. When the friction facings become worn these drive discs, which are quickly detachable in segments, may be removed and relined or replaced without disconnecting the engine from the compressor.

FOR VICTORY
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UNITED STATES
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BONDS
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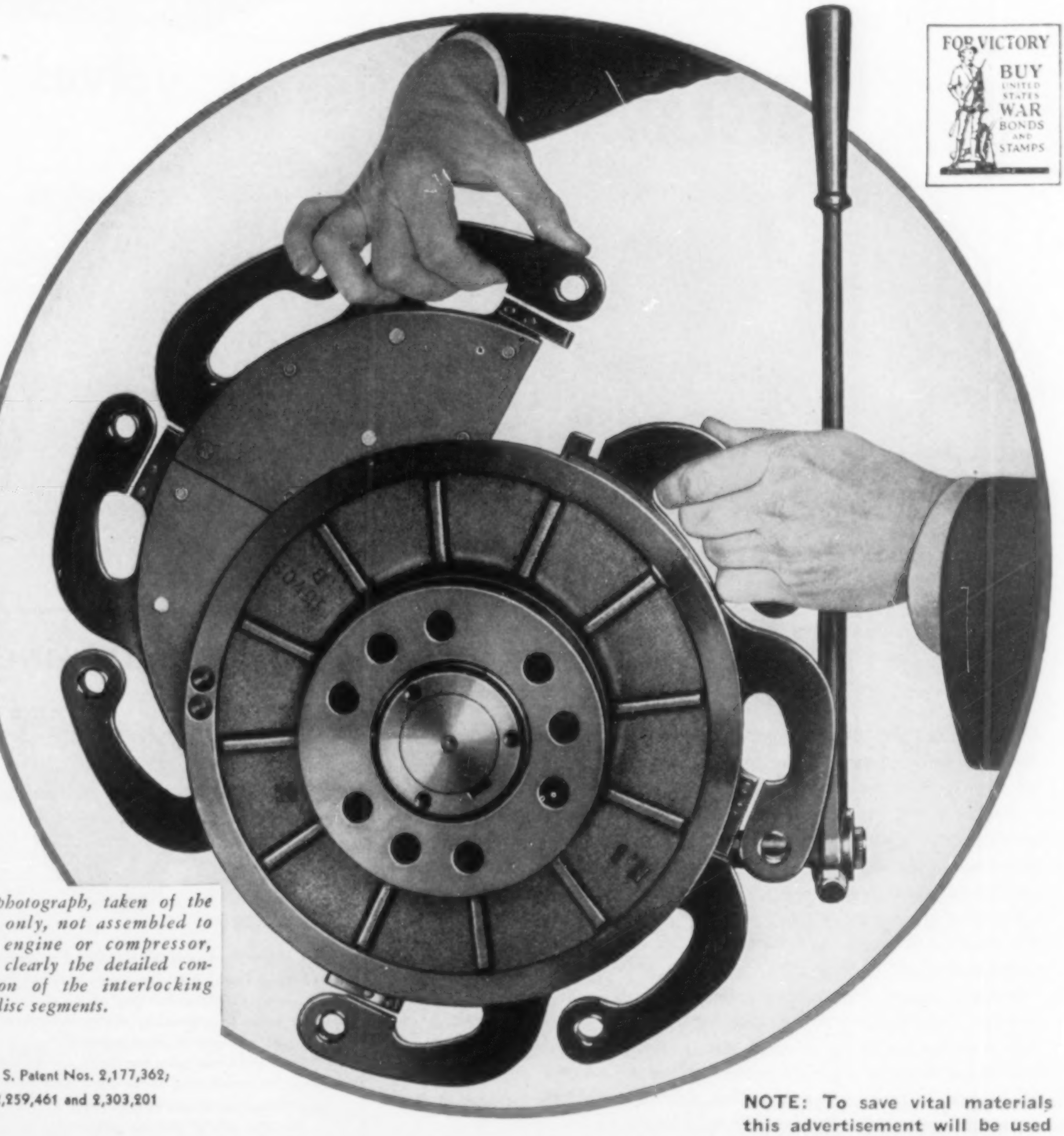
STAMPS



This photograph, taken of the clutch only, not assembled to either engine or compressor, shows clearly the detailed construction of the interlocking drive disc segments.

U. S. Patent Nos. 2,177,362;
2,259,461 and 2,303,201

NOTE: To save vital materials this advertisement will be used for "the duration."

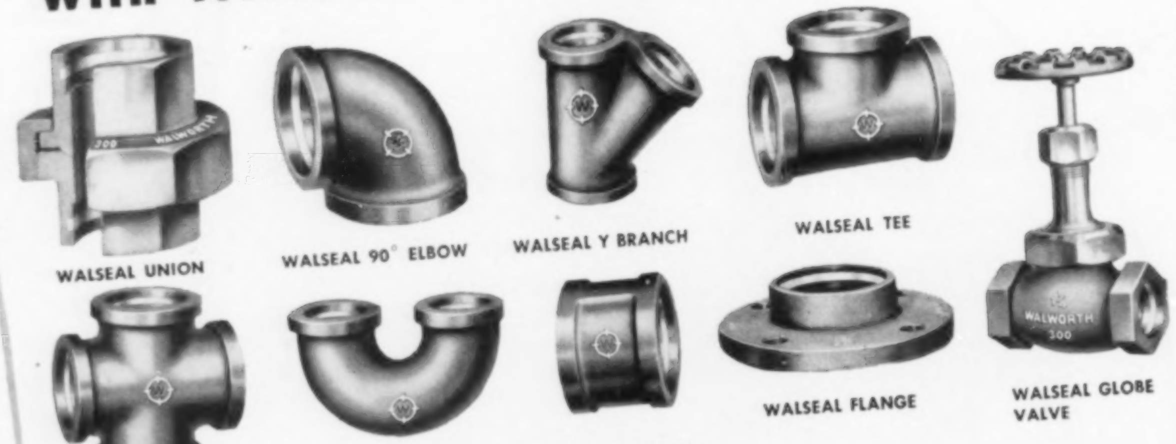
C. M. EASON, INDUSTRIAL CLUTCH CO.

Waukesha Wisconsin

Leakproof SILBRAZ* *joints*

IN COPPER OR BRASS PIPE

with WALSEAL* fittings, flanges, valves



(This illustration shows only a few of the many Walseal valves, fittings, and flanges made by Walworth.)

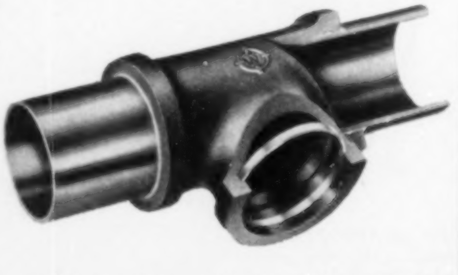
Silbraz joints are the strongest joints that can be made on brass or copper pipe or tubing They cannot creep or pull apart under any temperature or pressure which the pipe or tubing itself can safely withstand.

Silbraz joints are easily made with an oxyacetylene torch. When alterations to the line are necessary, Silbraz joints can be taken apart by reheating with the torch The Walseal valves or fittings used for making Silbraz joints may be re-used in the same or a new position. Enough alloy usually remains in the insert groove of the valve or fitting to permit a second Silbraz joint to be made, without the necessity of inserting additional alloy.

Walseal valves, fittings, and flanges for making Silbraz joints are a modern development of the Walworth Company – manufacturers of valves and pipe fittings for more than a century. For detailed information about Walseal products, write for Circular 84. For information on Walworth's complete line of valves, fittings, pipe, and pipe wrenches write on your company letterhead for a free copy of Catalog 42

* Registered trade marks

One-Piece PIPE LINES



The above illustrates the details of a Walseal tee and Silbraz joints. The center port has been cut away to show the ring of silver brazing alloy which is inserted by the manufacturer in the ports of every Walseal product

The right-hand port has been cut away to show the penetration of the alloy after the pipe and fitting have been silver brazed.

The left side of the tee shows the fillet of silver brazing alloy which completely encircles the pipe at the juncture of pipe and fitting — indicating that the Silbraz joint is completed. Because the brazing alloy penetrates both pipe and fitting, the resulting Silbraz joint actually makes the pipe and fitting into a one-piece pipe line.

ARMY E ARMY E NAVY

BOSTON WORKS
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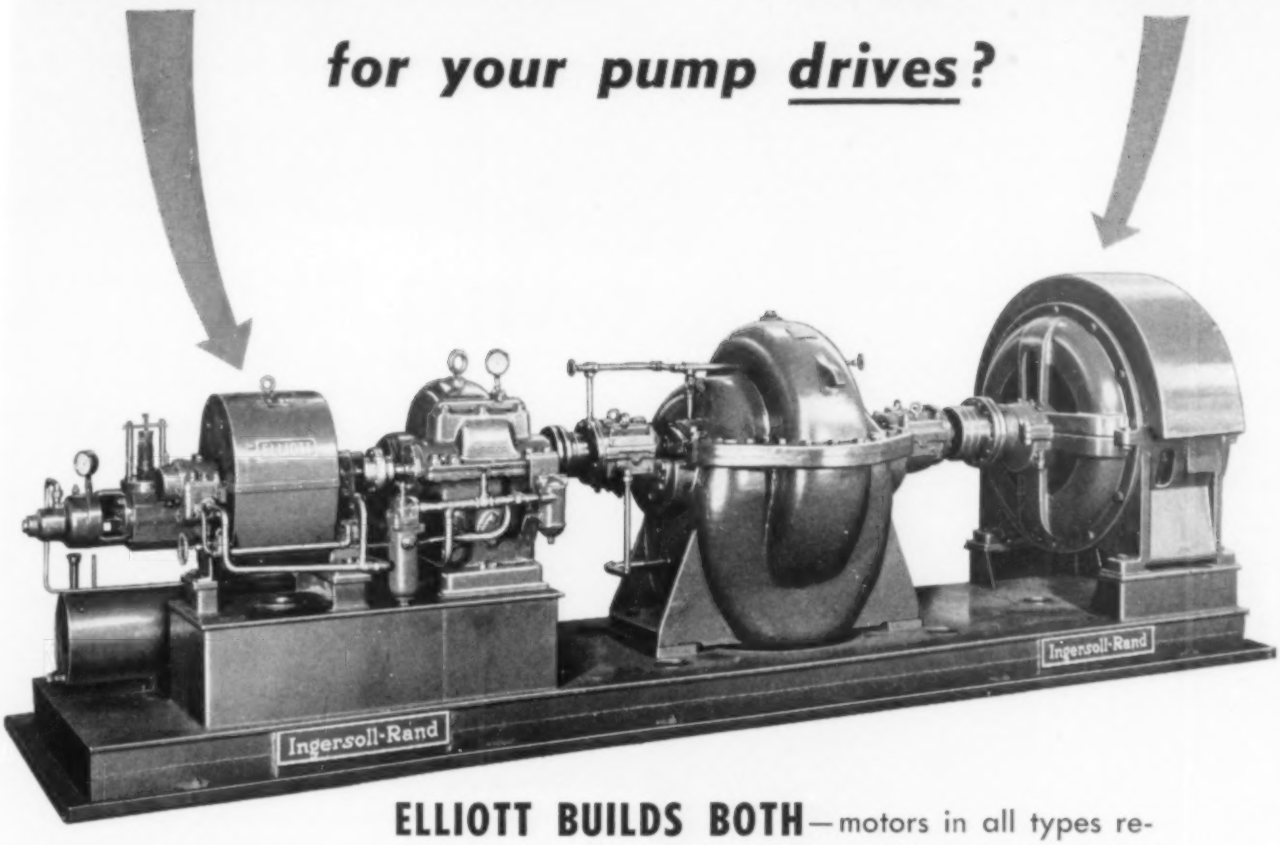

ELLIOTT BUILDS BOTH—motors in all types required for power plant auxiliary drives, with especial emphasis on two-pole, 3600-r.p.m. units. Turbines in single-stage or multi-stage, with or without speed reduction gears. The dual drive unit pictured is representative, being so arranged that electric power failure, reducing the r.p.m., would automatically open the turbine governor valve and bring the turbine into action.

Elliott auxiliary drive units, because of characteristically Elliott conservative design and emphasis on fine materials and workmanship, have extra performance built into them.

Whether it's turbine, motor, or dual drive, make it Elliott for assured performance.

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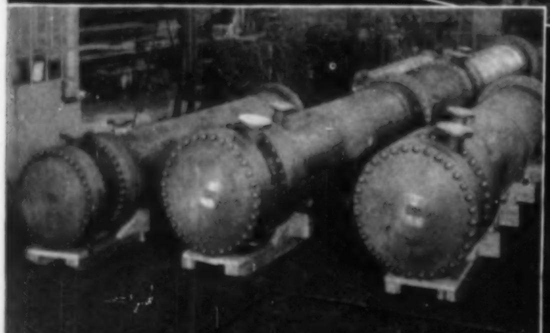
①

In WAR or PEACE its Vogt for better HEAT TRANSFER EQUIPMENT

②


③

① Heat Exchangers in the foreground have monel metal shells, admiralty metal tubes and naval bronze tube sheets, floating head covers, and baffles. Vogt Ell Bolts are used on floating head covers.

② Reactors for catalytic polymerization units being assembled and tested. Each is of welded construction and has bolted-on hinged covers.

③ Group of Diesel Oil Exchangers for a visbreaker. Used to exchange heat between diesel oil and corrosive crude containing salt and sulphur compounds.

④ 62"x30'-6" long Gas Cooler for a catalytic unit in a large refinery. Tube bundle at right is for a second unit.

HENRY VOGT MACHINE COMPANY
Incorporated
LOUISVILLE, KENTUCKY
Branch Offices: New York, Philadelphia, Cleveland, Chicago, Dallas.

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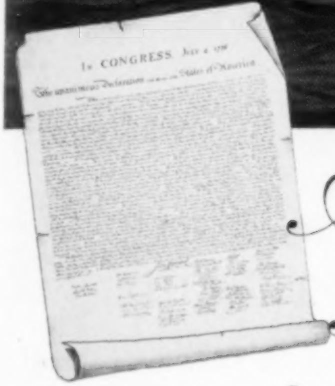
FOR BETTER
HEAT
EXCHANGERS

④

A TYPE AND SIZE FOR EVERY PURPOSE

VICTORY SHIPS

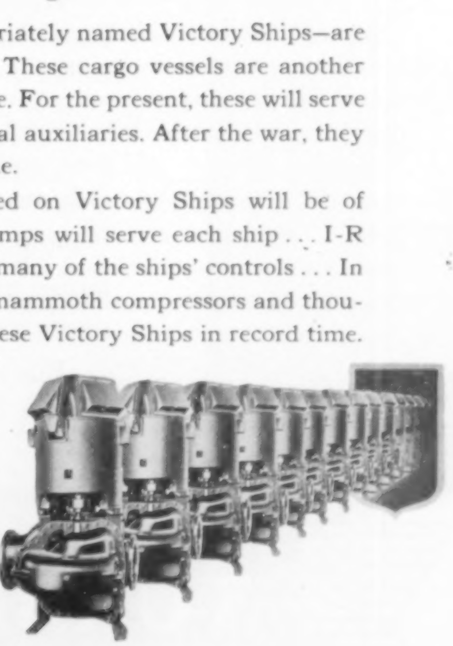


Another Declaration of American Independence

Some 300 high-speed merchant vessels—appropriately named Victory Ships—are now scheduled to come off our ways in 1944. These cargo vessels are another American declaration of sea-going independence. For the present, these will serve either as high-speed merchant vessels or as naval auxiliaries. After the war, they will be a dominant part of our Merchant Marine.

Most of the large centrifugal pumps used on Victory Ships will be of Ingersoll-Rand Cameron design. Five such pumps will serve each ship . . . I-R compressors also supply the air power used for many of the ships' controls . . . In the shipyards, the I-R trade mark is found on mammoth compressors and thousands of air tools—all helping crews to build these Victory Ships in record time.

Thus, Ingersoll-Rand equipment serves another of our major ship programs, just as it is serving at sea on battleships, carriers, destroyers, escort vessels, tankers, transports, tugs, tenders and cargo vessels.



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10-518

COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · OIL AND GAS ENGINES

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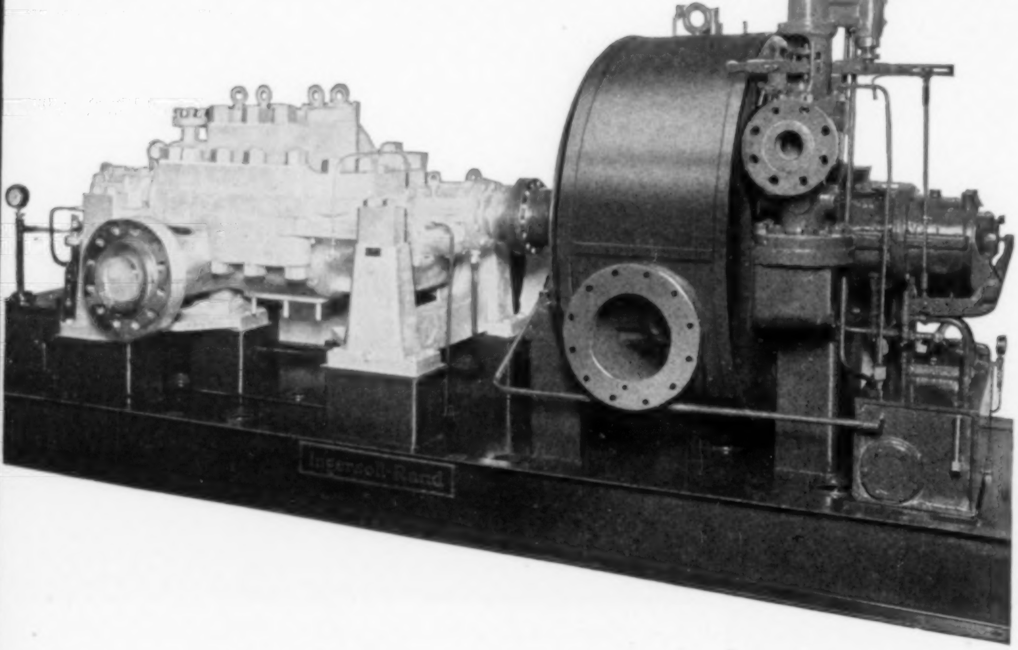


THE ROTOR OF THIS BOILER FEED TURBINE IS DOUBLE RIM PROTECTED!

The 1250 H. P. Turbine shown above employs the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly in the wheel.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

The Terry Wheel Turbine is fully described in our Bulletin S-116.

T-1152

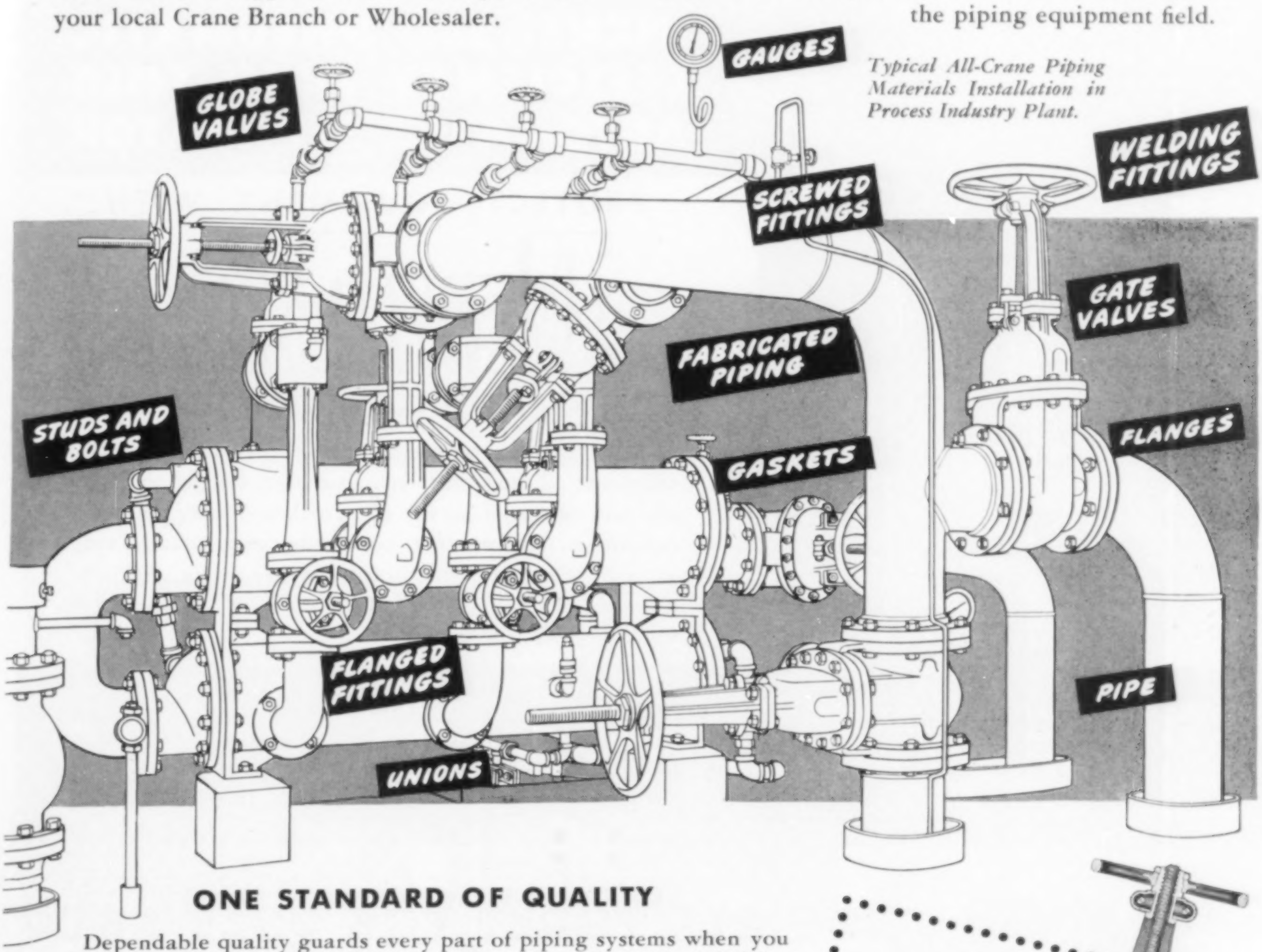
THE TERRY STEAM
TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Piping Materials for Any Need ...Crane Can Supply Them

ONE SOURCE OF SUPPLY . . . ONE RESPONSIBILITY FOR ALL EQUIPMENT

The easiest way to dispose of piping supply problems is to put them up to Crane. Doing that gives you the world's greatest selection of equipment for every service—power or processing systems, high or low working pressures. All your needs of valves, fittings, pipe, fabricated assemblies and piping accessories are supplied from one single source—your local Crane Branch or Wholesaler.

Now when you are trying to catch up with deferred maintenance, Crane *complete* piping materials service is a big advantage. From ordering to installation, every step of the job is simplified. And while one responsibility for materials helps assure the best installations, you are also getting full benefit of Crane Co.'s 89-year experience and leadership in the piping equipment field.



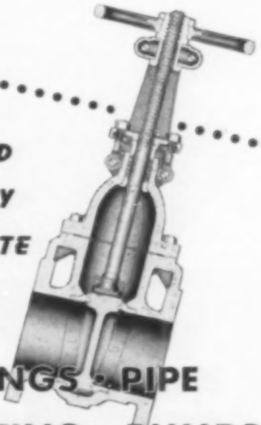
Typical All-Crane Piping Materials Installation in Process Industry Plant.

ONE STANDARD OF QUALITY

Dependable quality guards every part of piping systems when you specify Crane materials throughout. Such quality is exemplified by Crane Iron Body Wedge Gate Valves. Strong body sections resist severest strains. Straight-through ports permit unrestricted flow. A deep stuffing box lengthens packing life. Long guides keep disc travel true, while the finest design in every part assures long life and smooth, trouble-free service.

Crane Co., General Offices: 836 S. Michigan, Chicago 5, Ill.

Branches and Wholesalers Serving All Industrial Areas



STANDARD IRON BODY WEDGE GATE VALVES

CRANE

VALVES · FITTINGS · PIPE
PLUMBING · HEATING · PUMPS

Marine PRESSURE SWITCHES

DRIPPROOF AND WATERTIGHT
HIGH SHOCK CONTACT BLOCK—
TWO OR THREE POLE—CLASS 9013
TYPE AW-H, MW-H, LW-H

ELECTRICAL RATINGS

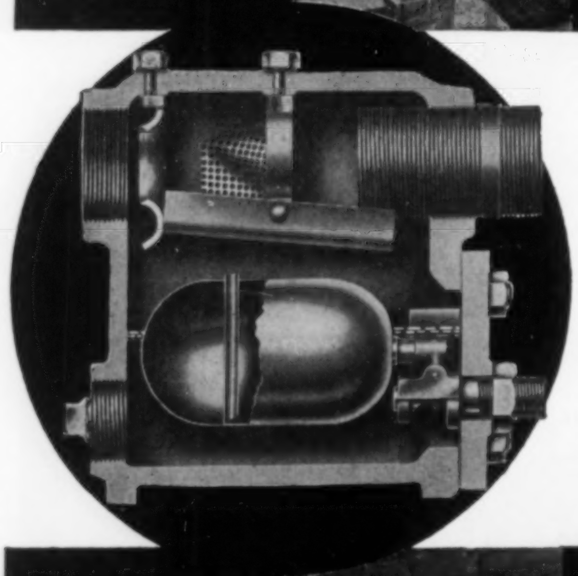
Voltage	Single Phase A.C.	Polyphase A.C.	D.C.
110V.	2 H.P.	3 H.P.	1 H.P.
220V.	3 H.P.	5 H.P.	1 H.P.
440-550	5 H.P.	5 H.P.	......
32V.	......	......	½ H.P.

• Built for Marine Service to conform with requirements for dripproof and watertight devices of shockproof construction. The switches differ from standard in the use of a special sheet steel enclosure and drip hood with gasket seal and a special high shock bakelite contact block in two or three pole form. The three types AW-H, MW-H and LW-H represent three diaphragm sizes and three range and differential variations. A release valve for air compressor service may be added to any of the types, as illustrated. Write for Bulletin 562.

REGULATOR DIVISION
SQUARE D COMPANY
DETROIT • MICHIGAN

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

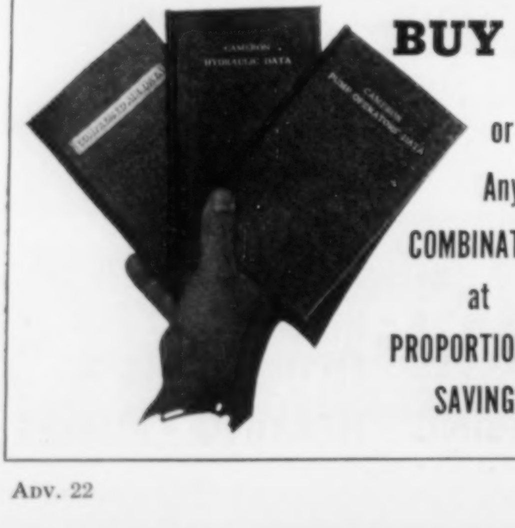
WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

BUY ALL THREE FOR ONLY $6.00



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Any
COMBINATION
at
PROPORTIONATE
SAVINGS

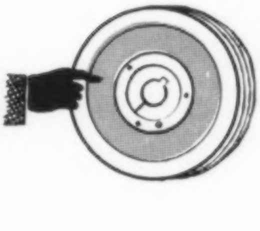
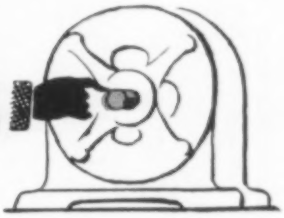
COMPRESSED AIR MAGAZINE, 942 Morris Street, Phillipsburg, New Jersey, U. S. A.

Please send me:

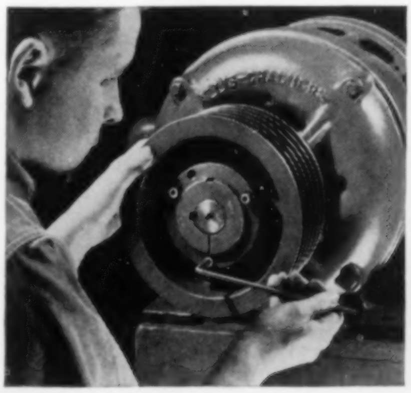
☐ Compressed Air Data, Cameron Hydraulic Data and Cameron Pump Operators' Data ....All three for $6.00.
☐ Compressed Air Data and Cameron Hydraulic Data ....Both books for $5.00.
☐ Cameron Hydraulic Data and Cameron Pump Operators' Data....Both books for $4.50.
☐ Compressed Air Data and Cameron Pump Operators' Data......Both books for $4.50.

☐ Enclosed is (money order) (check) for $........) ☐ Send books C.O.D. I understand that the books will be sent me postpaid, and that they may be returned within 10 days if not satisfactory.

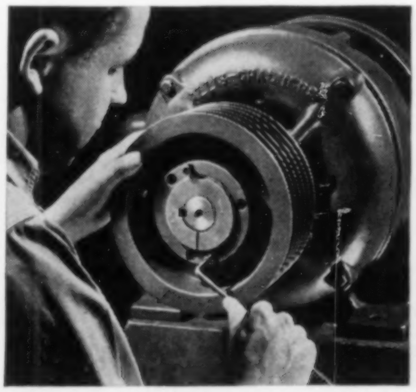
Name ....
Company ....
Street No. ....
City ....State.................Country ....

It doesn't take this to get this  off this 

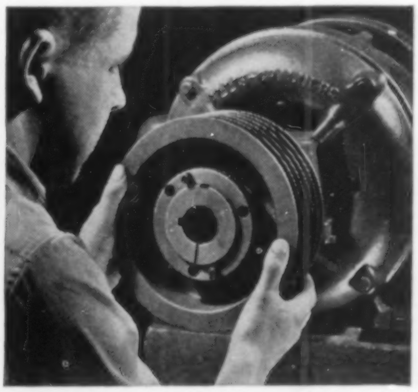
Allis-Chalmers' new "Magic-Grip" — *fastest mounting and demounting sheave on the market* — is removed from shaft in just 3 easy steps . . . saving you time, trouble, money.



1 **Remove three capscrews** from bushing collar. A handy wrench — supplied with each sheave — is the only tool needed to remove Allis-Chalmers' new "Magic-Grip" from motor or machine shaft quickly and easily.



2 **Insert two capscrews** in tapped holes. As screws are turned, they become levers . . . automatically breaking tight grip of tapered split bushing on sheave and shaft. Entire unit is then ready for removal.

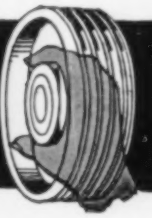


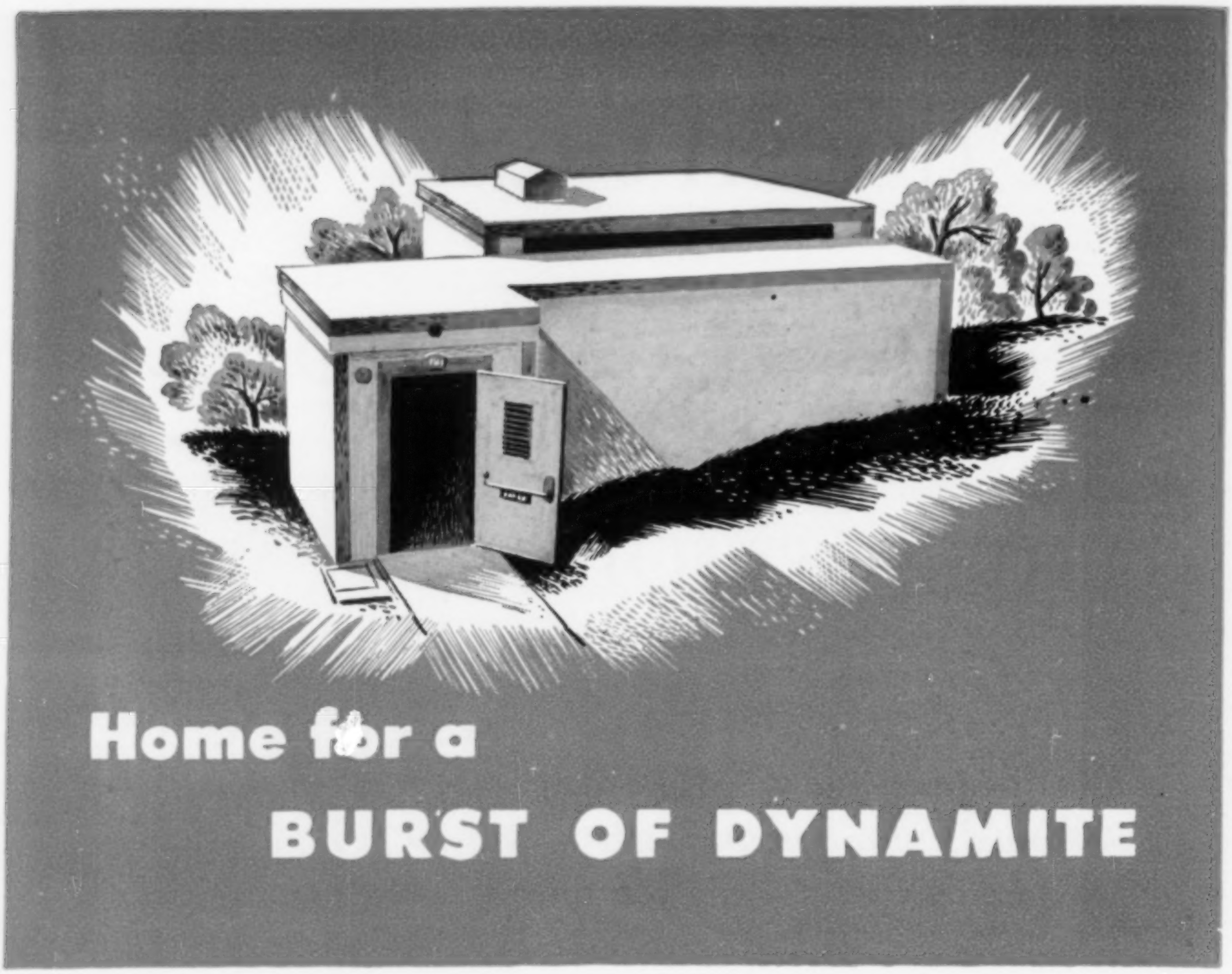
3 **Remove sheave from shaft.** Requires no mallet, no prying, no bulging muscles. You just slide the sheave off . . . smoothly, quickly. *It costs nothing extra!* Send for B6310. Allis-Chalmers, Milwaukee 1, Wis.

A 1758

Allis-Chalmers Texrope

"MAGIC-GRIP" SHEAVES





THIS BOMB-PROOF SHELTER is radically different from those on the war front. Here the "bombs" explode inside—set off by a remote control electric firing panel. A part of the hook-up is oscillographic equipment which permits the recording of firing times of various types of explosives.

Such experimental work, combined with field experience, contributes to the tremendous fund of knowledge which Hercules has accumulated over the years and is constantly enlarging for the benefit of the users of Hercules explosives everywhere.

HERCULES EXPLOSIVES

HERCULES POWDER COMPANY
INCORPORATED
932 King Street
Wilmington 99 . . . . . Delaware

10-43

GREAT MACHINES... *both of them!*

XVG
TYPE KVG

An 8-cylinder 300-hp XVG, and two 6-cylinder 600-hp KVG compressors in repressuring service.

for

PRESSURE MAINTENANCE
REPRESSURING
CYCLING
GASOLINE PLANTS
GAS LIFT
PIPE LINES
REFINERY SERVICE

When introduced twelve years ago, the XVG was *great* because it set new standards in gas-engine-driven compressors for oilfield and refinery service. Its V-angle, multi-cylinder design resulted in astonishing savings in the costs of installation, relocation and maintenance. It also established a new high in over-all economy of operation.

The XVG is even *greater* today. During these twelve years, it has been used in all types of applications, and the experience gained has naturally resulted in many improvements. In all parts of the world the XVG has proved the soundness of the V-angle design and 4-cycle simplicity... and the ability to operate continuously under full load for weeks and months without shutdown. It is still *the* compressor in the 75- to 300-horsepower size range.

The larger KVG compressor was introduced to meet the demand for compressors of larger capacity, and many units are now serving the synthetic-rubber and aviation-gasoline programs. It, too, is a *great* machine because it extends the outstanding features of the smaller machines to the 600- and 800-horsepower sizes. The KVG operates with a fuel economy of 9500 btu or less per horsepower-hour.

4-CYCLE
V-ANGLE DESIGN

If you have a gas-engine-compressor problem, our engineers will be pleased to work with you.

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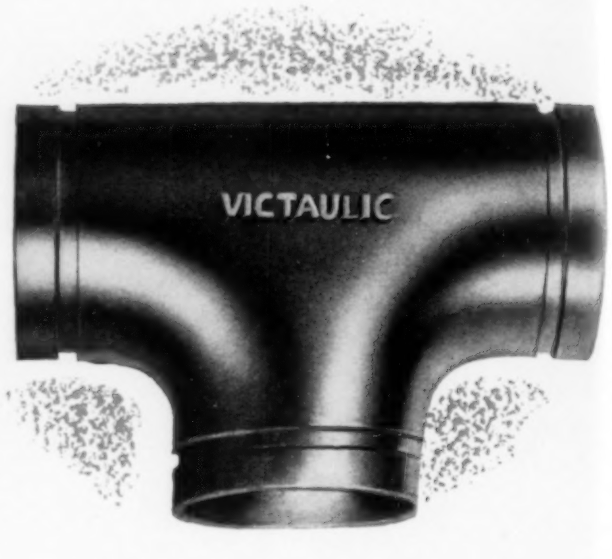
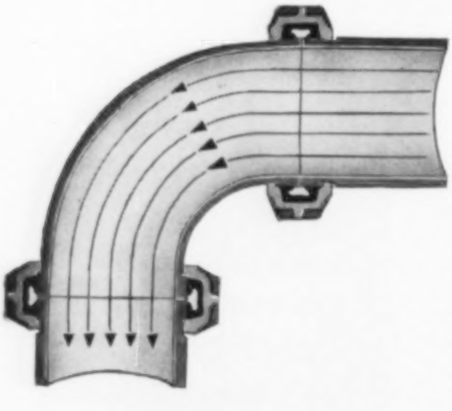
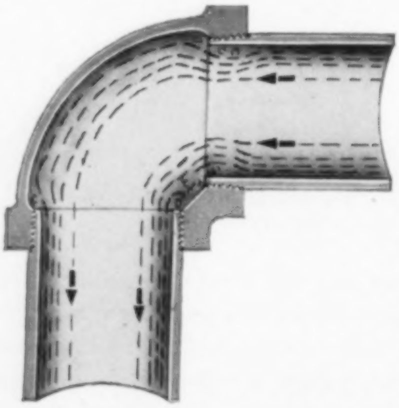
COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

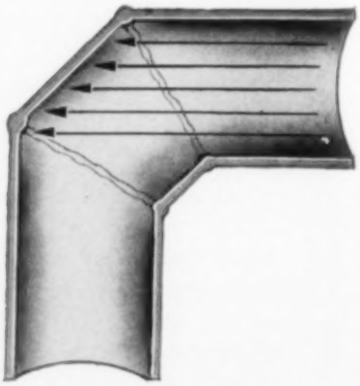
Pumping costs high?...



Install Victaulic Full Flow Pipe Fittings!







MORE EFFICIENT FLOW...REDUCED FRICTIONAL LOSSES

INCREASED EFFICIENCY

WAR BONDS
A PIPE LINE FROM YOU TO HIM

You can see the engineering difference! At your left on the flow diagram above . . . note the long radii, the wide smooth sweeps of Victaulic. Walls are smooth, true-circular with no internal projections, no pockets. Because they can be swiveled and set at any angle through 360 degrees, they act in effect as swing joints. You can remove them from the line without disturbing balance of the system.

For increased pipeline delivery, greater efficiency and economy, install Victaulic Full Flow Pipe Fittings...the companion line of the Victaulic Coupling, fastest known way to couple pipe. VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y.; Victaulic Inc., 727 West 7th Street, Los Angeles 14, California; Victaulic Co. of Canada, Ltd., 200 Bay Street, Toronto.

VICTAULIC
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SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

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OIL MINING MARINE MUNICIPAL INDUSTRIAL

IT LOOKS GOOD
and it is good

HEAVY STEEL BASE
Solid support for motor and compressor.

V-BELT DRIVE
Cog-type belts prevent slippage.

CRANKCASE BREATHER
Totally enclosed... Operates through filter... Keeps dirt out.

FILTER AND MUFFLER
Keeps dirt out... Increases compressor life... Reduces noise.

NATIONALLY KNOWN MOTOR
Service anywhere... Dependable and efficient.

SEMI-STEEL CYLINDERS
Carefully honed and lapped.

BALL-BEARING COMPRESSOR
Reduces friction.. Requires no adjustment.

Ask the Ingersoll-Rand jobber for complete information.
Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.

Ingersoll-Rand

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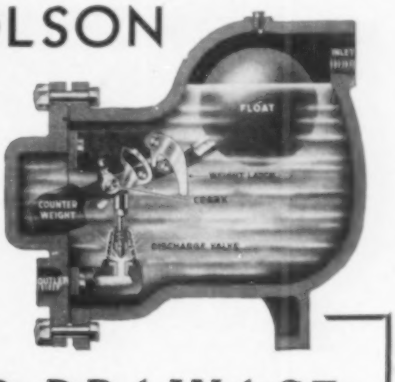
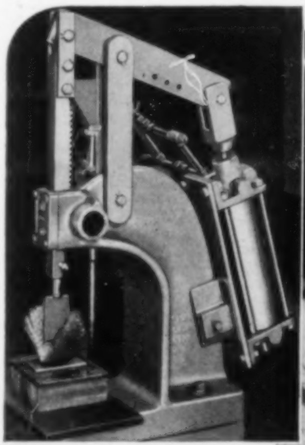
NICHOLSON
Model "JR"
TRAPS



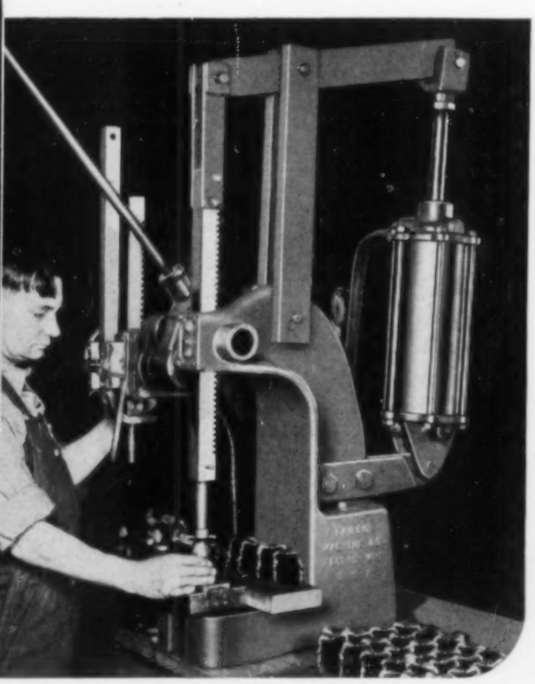
Provide
FASTER DRAINAGE
of All Air Systems

THE NICHOLSON MODEL "JR" COMPRESSED AIR TRAP, for automatically draining air separators, aftercoolers, receivers, etc., is weight-operated. Therefore the valve opens wide, instantaneously, permitting full, positive drainage before it closes. Intermittent, rapid opening and closing prevents wire-drawing of the accurately ground hardened stainless steel valve and seat. Large capacity. Water-sealed discharge valve. Welded stainless steel float. Bulletin No. 341.

W. H. **NICHOLSON** & CO.
—180 OREGON ST., WILKES-BARRE, PA.—
Valves ★ Traps ★ Steam Specialties



Small arbor press to crimp wire, powered by a small Model A NOPAK Cylinder mounted on hinged base.



Hand and air power both are used in this dual press equipped with 10" NOPAK Model E Cylinder.

Air Cylinders
STEP-UP
BRUSH PRODUCTION

With new machinery and experienced help hard-to-get . . . the war-time demand for circular wire brushes created a real problem for The Milwaukee Brush Mfg. Co. Modernization of existing equipment was the happy solution . . . increased production tenfold with only twice as many workers.

A vital step in this modernization was the application of air cylinder power to various types and sizes of arbor presses which perform many of the holding, clamping and squeezing operations in assembling these brushes. Altogether, nearly twenty machines were converted to air operation. Foot control valves leave the operators' hands free to manipulate tools, dies and parts for speedy assembly.

Perhaps some of your machines can be modernized through the application of air or hydraulic power. NOPAK Cylinder Bulletin 82 can help you decide. Write for it.

GALLAND-HENNING MFG. CO.
2759 S. 31st ST. MILWAUKEE, WIS.

Representatives in Principal Cities

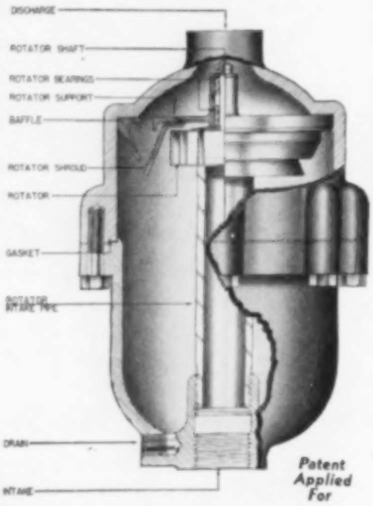
NOPAK VALVES and CYLINDERS
DESIGNED for AIR or HYDRAULIC SERVICE

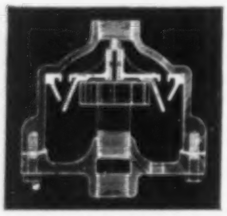
A 4552-½H-A

NEW TURBO-ROTOR *Pur-O-fier*

For Compressed Air

This new unit effectively eliminates moisture, oil and scale from compressed air lines. Pur-O-fier utilizes the principle of centrifugal force to separate entrainments from purified air. Once installed it requires absolutely no maintenance. Penstar Tru-Bond oiless bearing guarantees long, trouble-free operation. Manual or automatic drains provided.





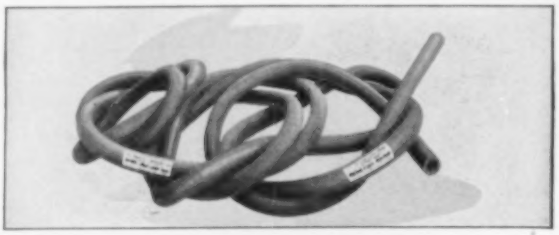
Drawing shows turbo-rotor, shroud and baffles. The design of the baffles precludes the possibility of capillary action of entrainments resulting from high velocity.

THREE MODELS AVAILABLE—A-1 will accommodate volumes from ½ to 5 cu. ft. A-2, volumes from 10 to 35 cu. ft. A-4, volumes from 35 to 100 cu. ft. Multiple units are recommended for volumes above this range. Pur-O-fier is the only standard unit that can be engineered to meet any air volume for regular or intermittent service.

BIRD-WHITE COMPANY
3120 West Lake Street, Chicago, Illinois

Condor AIR HOSE
HOMO-FLEX

with FLEXLASTICS* and balanced, engineered construction



Condor Homo-Flex Air Hose is a new type hose—rugged, light in weight and flexible . . . it will not kink, coil or twist. Made with a thick inner tube to resist the deteriorating effects of oil and coupling wear. Has super-strength cords embedded in FLEXLASTICS* to form the Strength Members . . . and a heavy, abrasion-resisting cover of FLEXLASTICS* to give Condor Homo-Flex Air Hose great strength and resistance to high working pressures.

Practically inseparable cover and plies; uniform inside and outside diameters; and resistance to elongation and expansion are other advantages.

52nd YEAR

*The term FLEXLASTICS is a MANHATTAN trade mark. Only MANHATTAN can make FLEXLASTICS.

THE MANHATTAN RUBBER MFG. DIVISION
OF RAYBESTOS-MANHATTAN, INC.
Executive Offices Passaic, New Jersey

Here's an up-to-date AMERICAN *guide on*

CENTRIFUGAL PUMPS and BLOWERS

By AUSTIN H. CHURCH, M.E. Sc.M., *Associate Professor of Machine Design, New York University*

Supplying basic design theory, construction and application in use today—this long-awaited book is a modern work in English on centrifugal compressors and blowers—written from the *American* viewpoint. It presents essential time-tested material and methods that explain standard practice—plus basic information needed to understand and apply new theories as they develop.

CONTENTS INCLUDE:

• Principles of Fluid Flow • Basic Theory of Pumps and Blowers • Specific Speed and Efficiency of Pumps • Performance Curves and Cavitation of Pumps • Design of Radial-Type Pump Stage • Other Pump Impeller Types • Pump Details and Materials • Pump Applications and Selection • Pump Installation, Operation, and Test • Thermodynamic Principles • Classification and Performance Curves of Blowers • Design of Radial-Type Blower Stage • Construction Details of Blowers • Blower Applications • Regulation of Blowers • Blower Installation, Operation and Test • Disk Stresses • Critical Speeds.

308 Pages **$4.50**

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Please send me on ten days' approval a copy of Church's CENTRIFUGAL PUMPS AND BLOWERS. At the end of that time, if I decide to keep the book, I will remit $4.50 plus postage; otherwise I will return the book postpaid.
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INVESTIGATE

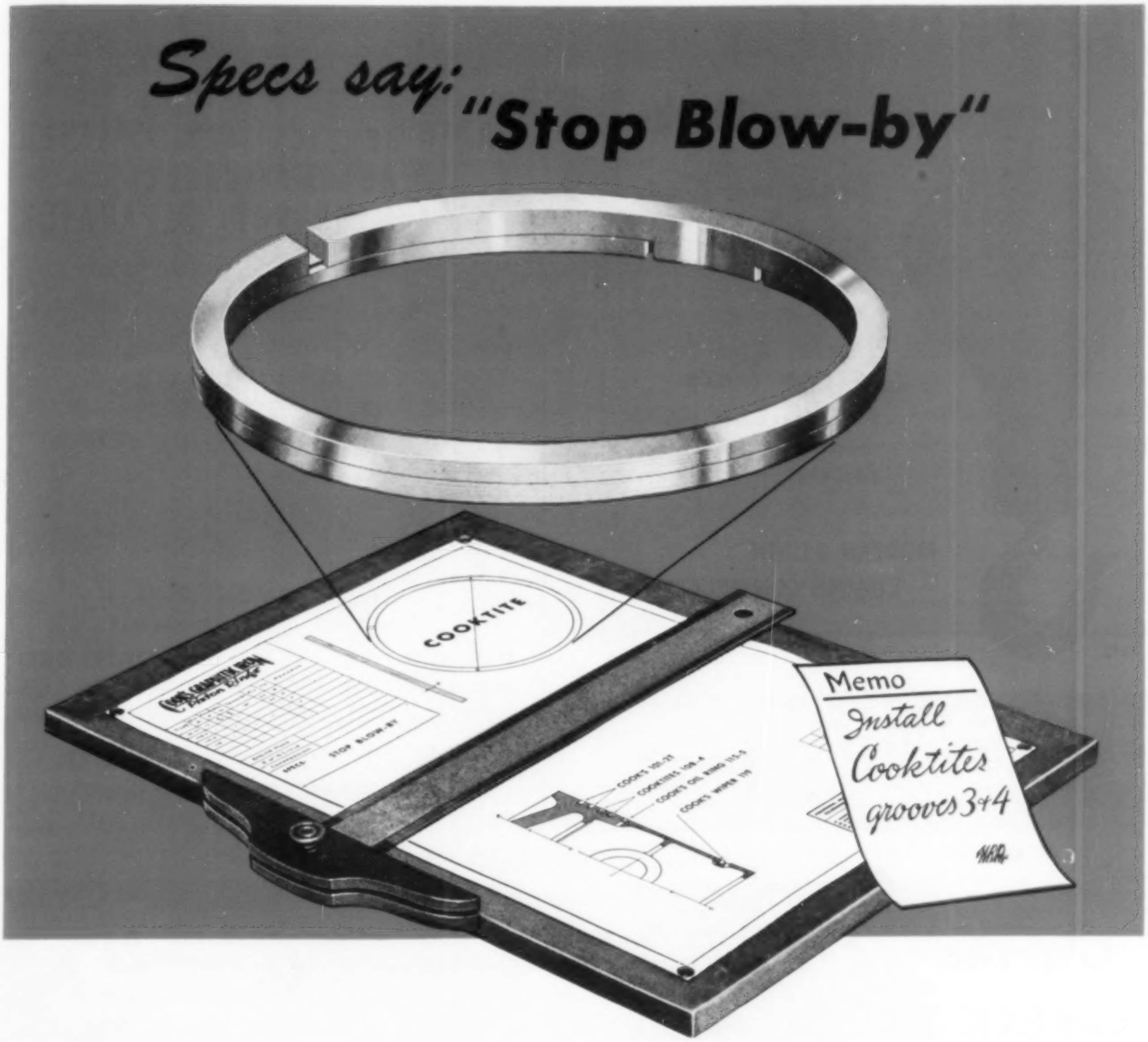
Farris

SAFETY AND RELIEF VALVES

- Designs based on actual field experience and requirements . . . built for the service, not adaptation of other designs.
- Sensitive for immediate response and close regulation. Full flow valve bodies with large passages to minimize back pressure. Precision machine tolerances . . . rigorously inspected and throughly tested.
- Many thousands in use on U. S. Naval and merchant marine vessels and stationary installations.
- Every type . . . for every purpose . . . to all code requirements, including Navy, ABS, and other applicable specifications. Open and enclosed springs . . . portable pops, boiler safetys, liquid reliefs for all liquids, packed and unpacked types.
- Sizes ½″ to 8″ . . . pressures to 600 pounds.

BULLETIN ON REQUEST

FARRIS ENGINEERING COMPANY
354 Commericial Avenue Palisades Park, N. J.



BLOW-BY in a Diesel is a costly waste of fuel. This leakage of compression through the gap openings of ordinary rings past the piston, also beaks down the essential oil film on the cylinder walls which accelerates cylinder and ring wear.

For positive and lasting seal of compression, install COOKTITES—they eliminate blow-by because there are no gap openings through which the gas can escape and they continue to function as gapless rings throughout their life.

The ever increasing use of COOKTITES, since their introduction in 1930, is evidence of their success. As one engine builder put it recently'' . . . Since installing COOKTITES the engine develops more horsepower than it did when new.''

Your Diesel, too, if it is an industrial size engine, will operate much more efficiently after the installation of COOKTITES. Usually, only two COOKTITES per piston will do the trick.

So, in preparing ''Specs'' to cover orders for replacement rings—or for a new engine—specify COOKTITES.

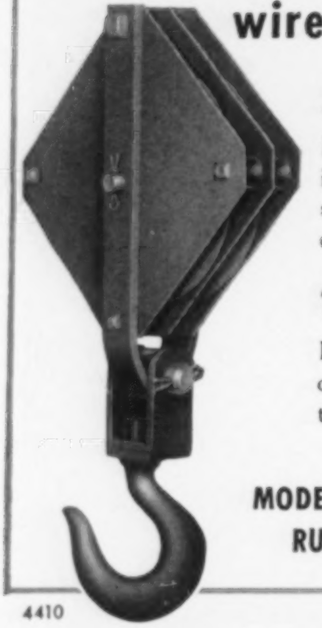
COOK'S engineers will gladly assist you in selecting the correct ring combination for your specific condition. Your inquiries are invited.

C. LEE COOK MANUFACTURING CO. INCORPORATED, LOUISVILLE, KY.

"Sealing Pressures Since 1888"

COOK'S METALLIC PACKINGS

AMERICAN



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Standard Duty

For average work which includes most of the service in industry and construction.

Heavy Duty

For extremely heavy construction and erection work.

MODERN DESIGN
RUGGED CONSTRUCTION

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THE GENUINE
Crosby Clip
WHEREVER WIRE ROPE IS FASTENED

There Is No Compressed Air Condition So Bad In Any Factory That We Cannot Correct and Completely Remedy

WATER removed from AIRLINES
AUTOMATICALLY
with the MURPHY SEPARATOR

AIR OUTLET
AIR INLET
WATER EXHAUST

SIZES ½" TO 4" PIPE
Literature and Prices on request

RESULTS - - - GUARANTEED
NO ABSORBENTS - NO CHEMICALS
AFTERCOOLERS - - - SPRAYERS

JAS. A. MURPHY & CO.
HAMILTON, OHIO

Oil the AIR and
CHECK THE WEAR

A hundred thousand NORGREN units are helping air tools stand up to the beating of 3-shift production. They're doing more! NORGRENS guarantee you *maximum power* from every air tool; *maximum man-hour output.*

NORGREN Lubro-Control UNITS (1) Clean the air; (2) Regulate pressures; (3) Inject exactly enough oil into air stream to maintain a film on every moving part.

Check wear during use. Prevent destructive corrosion when idle.

Get Catalog 400

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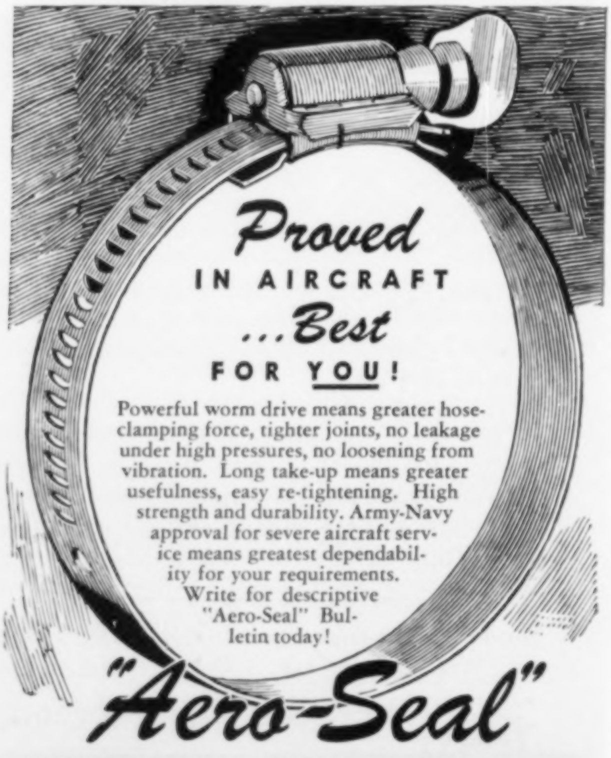
C. A. NORGREN CO., DENVER, COLO.



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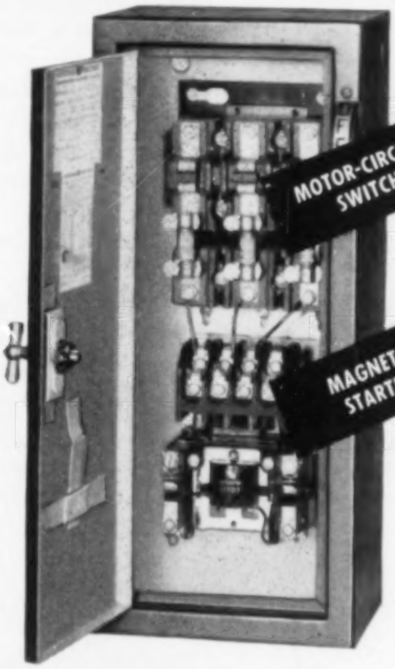
IN AIRCRAFT
...Best
FOR YOU!

Powerful worm drive means greater hose-clamping force, tighter joints, no leakage under high pressures, no loosening from vibration. Long take-up means greater usefulness, easy re-tightening. High strength and durability. Army-Navy approval for severe aircraft service means greatest dependability for your requirements. Write for descriptive "Aero-Seal" Bulletin today!

"Aero-Seal"
HOSE CLAMPS

AIRCRAFT STANDARD PARTS CO., 1771 19th AVE., ROCKFORD, ILL.

MOTOR STARTERS EVERY TYPE, EVERY KIND, FOR EVERY MACHINE APPLICATION



COMBINATION STARTERS

DEPENDABLE . . . ATTRACTIVE IN APPEARANCE . . . DESIGNED TO BLEND WITH MODERN MACHINES

Advantages of Combination Starters

1. ***50% reduction in mounting time***—You mount only one device, not two.
2. ***40% reduction in wiring time***—Connect to only 9 terminals, not 15. The switch and starter come connected.
3. ***Sure safety***—Cover cannot be opened while power is on the starter.
4. ***Reliable motor protection***—Protection devices co-ordinated at factory.
5. ***Saving of wall space***—The one device takes less space than two.
6. ***Improved plant appearance***—Single, streamlined case; less open wiring and conduit.

Whatever your plant's operating condition, you can get a suitable G-E combination control. This means a motor-circuit switch (with short-circuit protection) and a magnetic starter—in one, compact, easy-to-mount unit.

Write today for more information about these combination starters. Our engineers will be glad to help you select just the right starter for your application. *General Electric Company, Schenectady 5, N. Y.*

GENERAL PURPOSE

Suitable for general-purpose indoor applications where atmospheric conditions are normal.

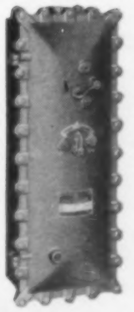
CORROSION RESISTANT

Made for corrosive atmospheres and hazardous locations. All arcing parts and terminals (of forms for hazardous locations) are at least six inches under oil.

DUST-TIGHT

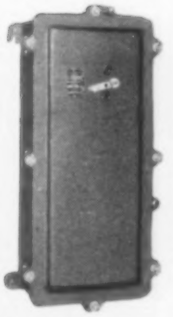
For use in steel mills, cement mills, and other locations where the dust content of the atmosphere is heavy.

FOR HAZARDOUS LOCATIONS



Designed to withstand internal explosions. The flanges, which are securely bolted on all sides, are ground to tolerances which will not permit the escape of gases.

WATER-TIGHT



Suitable for outdoor use, and for damp places indoors, such as dairies, breweries, and ship docks.

Buy all the BONDS you can—and keep all you buy

GENERAL ELECTRIC

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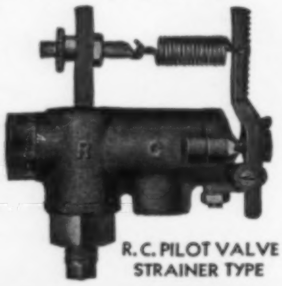
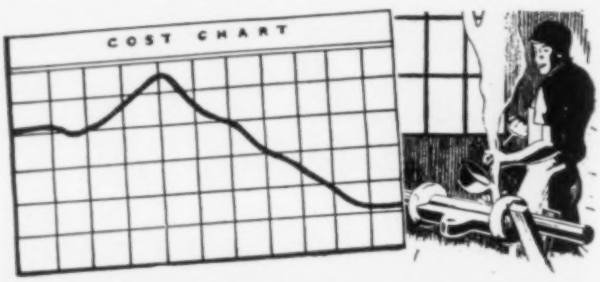
R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders



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- Babbitrite is also used in casting low-melting alloys, in heat treating, in product cleaning and finishing.

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WET DIRTY AIR
DRAIN

The useful life of thousands of tools and equipment parts has been shortened and finished products in appalling volume have been scrapped because air was used as it came from the compressors or the air cleaning method employed effected only partial removal of contamination.

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Dries and Cleans Compressed Air

REMOVES OIL WATER DIRT

...THE END OF THE LINE

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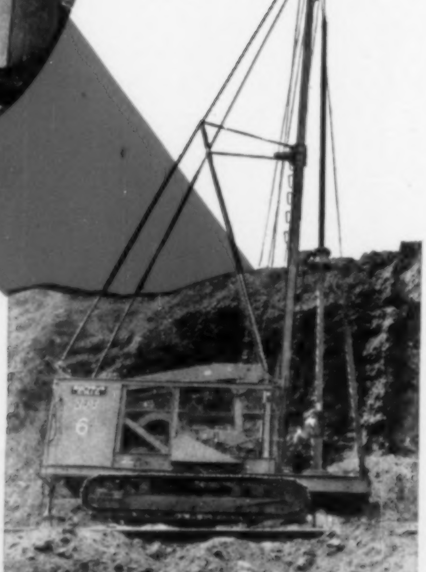
Plan now to include Bucyrus-Eries in your postwar equipment. With Bucyrus-Eries you'll profit most — because you'll have the best.



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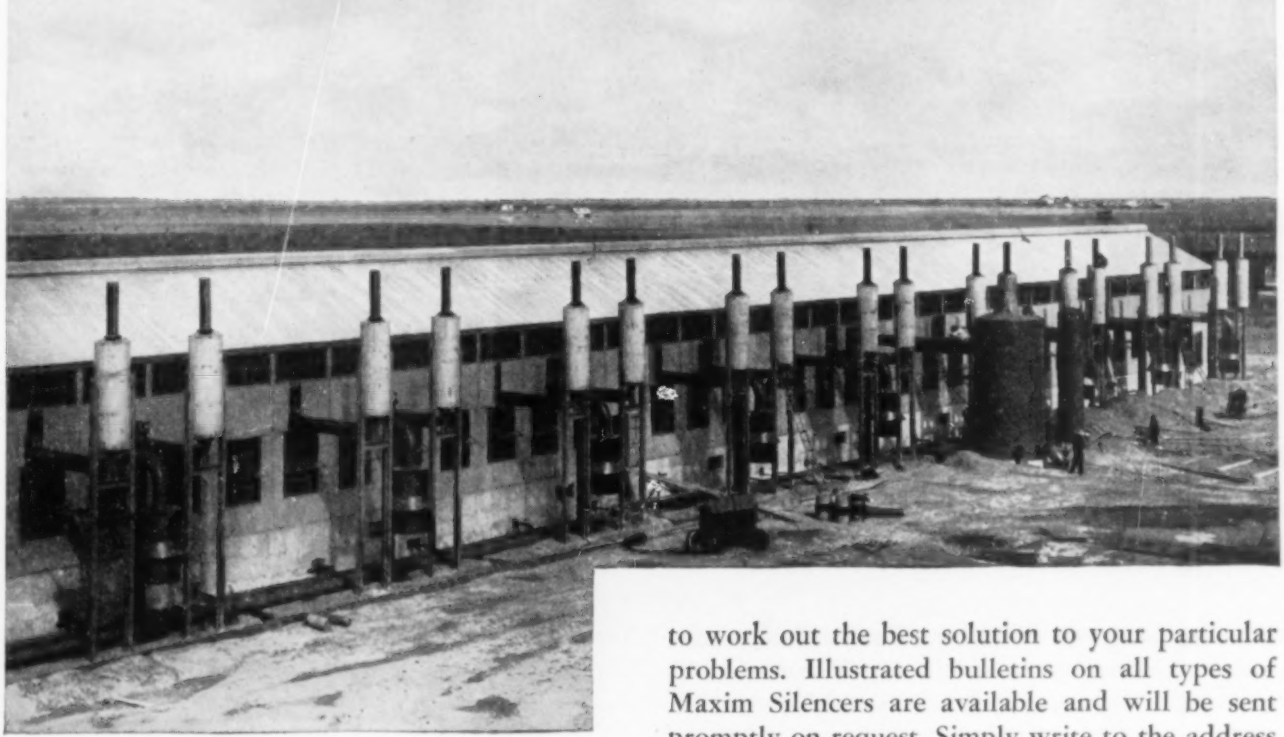
MAXIM SILENCERS ON ALL COMPRESSOR STATIONS OF LONGEST GAS PIPE LINE SINCE 1932



The longest gas pipe line since 1932, built by Tennessee Gas and Transmission Co., extends from Corpus Christi, Texas to Cornwall Station, West Virginia, a distance of 1265 miles.

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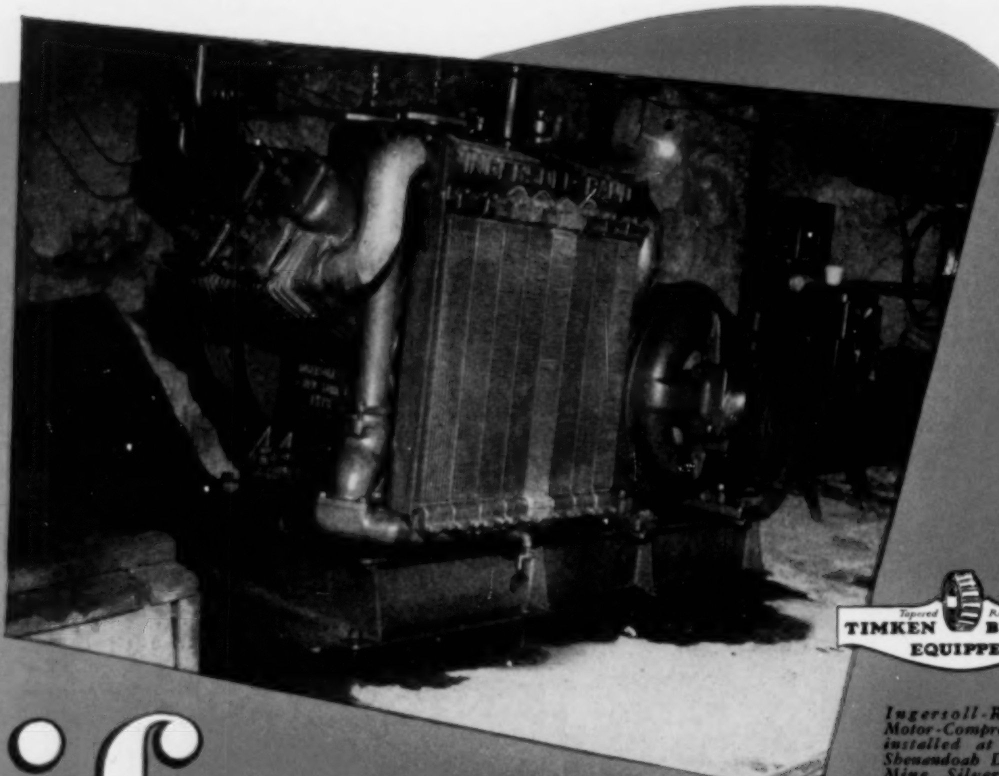

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